Advanced Materials Research *Online: 2011-01-20*
ISSN: 1662-8985, Vols. 175-176, pp 999-1004
doi:10.4028/www.scientific.net/AMR.175-176.999

Study on Relationship between Mechanical Properties and Seam Smoothness Worsted Fabric

Hong Ni [1, a] & Rui Fan [1, b]

[1]Jiangyin Polytechnic College, Jiangyin City, 214405, Jiangsu Province, China

[a] jynh0608@126.com, [b] frjy2000@sina.com

Keywords: Worsted Fabric; Mechanical Properties; Seam smoothness; Air Temperature and Humidity Conditions; Relationship.

Abstract. The instability of seam smoothness for worsted fabric is always a big problem in suit industry. With substantial development and application of new worsted fabric as well as the comprehensive application of various fiber materials，it is difficult to control seam smoothness of suit, creating the quality of suite to descend and adversely affecting the brand development in suit industry. The purpose of this paper is, therefore, intending to study the relationship between worsted fabric mechanical properties and garment seam smoothness grade as well as the effect of environmental air temperature and humidity conditions on smoothness of seam sample, by selecting several pieces of worsted fabrics and testing their mechanical properties through FAST. The goal of this paper is to facilitate textile and garment enterprises to improve their own textile process and finishing as well as the sewability of worsted fabrics.

Introduction

Seam smoothness is a key indicator among suit quality indicators. In References [1-6], a specific sample has been studied and several objective evaluation systems on predicting seam smoothness have been established. The complex compositions of raw material for suit fabric led to different mechanical properties and distinguished garment styles. As the natural fibers featured by strong moisture absorption, such as wool, silk, flax and cotton are widely used, the mechanical properties of suit fabric vary with different relative environmental humidity and so does the suit seam smoothness. Based on suit worsted fabric used by the cooperative enterprise in the subject as object of study, this paper is to analyze the relevance between mechanical properties of fabric and garment seam smoothness and to seek the root affecting the seam smoothness, by testing its mechanical properties with FAST(Fabric Assurance by Simple Testing). And meanwhile, this paper also studies the relationship between the seam smoothness of worsted fabric and the environmental temperature and humidity conditions for textile and clothing enterprises to perfect their textile processing and finishing as well as improve the sewability of worsted fabrics so as to fundamentally solve the chronic problem on unsTable seam smoothness of worsted fabric.

Testing

Sample Preparation. For testing, 50 kinds of worsted suit fabrics, whose raw materials are mainly composed of wool fiber and supplemented with such materials as cotton, hemp, silk, dacron, cashmere, polyamide, tencel, spandex and conductive fibers, etc. Please see Table 1 for detailed specifications.

Table 1 Testing Fabric Specifications

Testing Sample	Raw Compositions	Linear density of Warp/tex	Linear density of Weft /tex	Fabric Weave	Areal Density/(g·m^{-2})
Light-thin ~Mid-thick Wool Fabrics	Wool, Cotton, Hemp, Silk, Dacron, Cashmere, Polyamide, Tencel, Spandex and Conductive Fibers	18.9~55.6 Single Yarn & Double Strand Yarn	18.9~55.6 Single Yarn & Double Strand Yarn	Plain, Twill, satin, Broken Twill, Basket, Satin Backed, Crepe, Warp Backed Weave	133~225

Mechanical Properties Testing of Fabric Sample. FAST (Fabric Assurance by Simple Testing) is recognized in textile and clothing industries as simple and efficient system to test the mechanical properties of wool-like fabrics. This testing is to determine the compressing, bending, tensing and shearing performance and stability of size of samples by means of FAST (Fabric Assurance by Simple Testing) at standard temperature and humidity (20℃ and 65%RH), with 20 indicators in total, and obtained the testing results.

Sewing Test of Fabric Sample. ***Sewing Conditions.*** The purpose of this study is to inspect the warp seam smoothness. The sewing strips with cutting of 30cm (warp) x 10cm (weft) is only required, because in most cases, the clothing pieces are cut symmetrically and during sewing, the cut pieces are sewn in the same fiber direction. The completion of sample sewing was performed on JUKI DDL8500 industrial sewing machine by skilled workers in garment factory. Please see Table 2 for sewing conditions.

Table 2 Sewing Conditions

Sewing Type	Sewing Thread / tex	Stitch Density/ (needles /3cm)	Needle Type/Number	Seam Width/mm
Press seam	9.8×3 Polyester Staple Fiber Yarn	13~14	14	15

Seam smoothness Acquisition. The evaluation of seam smoothness is performed in visual subjective evaluation method. 3 professionals are employed to rate each piece of sewing strip sample in accordance with AATCC—88B seam surface smoothness standard sample, and the average is taken. As the seam smoothness changes with environmental air conditions in actual garment production, the sewn sample during this test is washed and dried as per the standard as well as well ironed first, then placed inside the dry oven at 105 ℃ for an hour; after the sample is taken out, the seam smoothness of sample is rated at once.

Later, place the sample in the standard conditions of temperature and humidity to balance for 8 hours, and rate its seam smoothness; then place the sample at the temperature of 20℃ and in the

humidity of 100%RH to balance for 8 hours, and rate its seam smoothness.

Analysis on Correlation of Fabric Performance and Seam Smoothness

Based on the production process of garment and the practical experience of enterprises, when the fabric was being sewn under comprehensive effects of such external forces as pressure of presser foot, penetrating power of sewing needle, thrust of feed dog, drawing forces of the top and bobbin threads of sewing thread as well as thrust and pull force of operator, etc, the smoothness of fabric seam is closely related to the applied force. Therefore, it can be concluded that under low load, the mechanical properties of fabric is related to its smoothness. With the application of software MATLAB7.0 and calling function of corrcoef, after the correlation to the relation between seam smoothness of sample and mechanical properties of fabric in the standard temperature and humidity conditions (20 ℃, 65% RH) is analyzed，the result is shown as Table 3.

Table 3 A Summary List for Correlation Coefficient of Sample Sewing Smoothness and Fabric Mechanical Properties

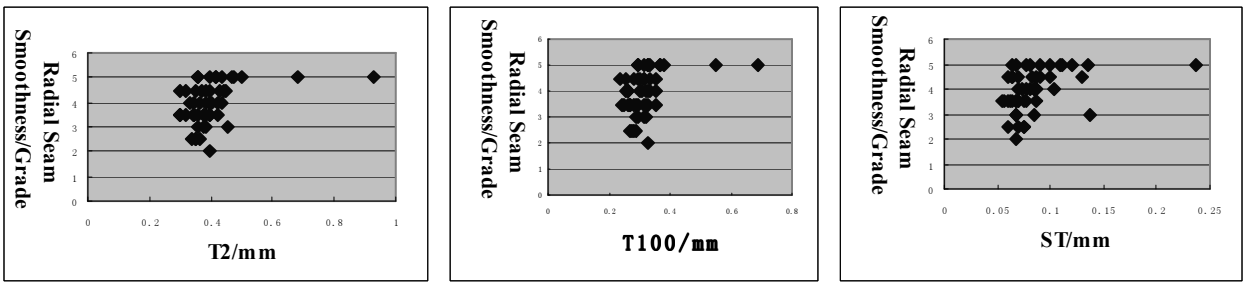
Correlation Coefficients	W /(g·m^{-2})	RS-1 /%	RS-2 /%	HE-1 /%	HE-2 /%	F-1 /mm^2	F-2 /mm^2
Warp Seam smoothness	0.183816	-0.31345	-0.30921	0.164644	-0.05979	0.377023	0.131598
Correlation Coefficients	E5-1 /%	E5-2 /%	E20-1 /%	E20-2 /%	E100-1 /%	E100-2 /%	EB5 /%
Warp Seam smoothness	0.342177	0.131106	0.324711	0.190145	0.315258	0.154378	0.14729
Correlation Coefficients	B-1 /(μN.m)	B-2 /(μN.m)	G /(N·m)	T2 /mm	T100 /mm	ST /mm	Warp Seam smoothness
Warp Seam smoothness	0.334859	0.349426	-0.08762	0.390848	0.376826	0.378213	1

The warp seam smoothness of sample is negatively related to the warp relaxation shrinkage RS-1 and RS-2 of fabric sample. It is little related to such indicators as area density W, fabric warp hygroexpansivity HE-1 and weft hygroexpansivity HE-2 and weft formability F-2, weft elongation E5-2，E20-2，E100-2, 45° oblique elongation EB5 and shear stiffness G and it is significantly related to the warp fabric formability F-1, warp elongation E5-1, E20-1 and E100-1, warp and weft bending rigidity B-1 and B-2, thickness T-2 and T-100 as well as surface layer thickness ST. Therefore, it showed that the impact of warp formability F-1, warp elongation E5-1, E20-1 and E100-1, warp and weft bending rigidity B-1 and B-2, thickness T-2 and T-100 as well as surface layer thickness ST on warp seam smoothness is greater and the impact of the other mechanical properties on the warp seam smoothness is weaker.

Relationship between Fabric Thickness and Warp Seam Smoothness. The relationship between the seam smoothness as well as the fabric thickness T2 of sample under 1.96 cN, T100 under 98.1 cN and surface thickness ST was shown in the form of scatter diagram respectively as Fig. 1（1）（2）（3）. It indicates by studying Fig.s that the fabric seam smoothness is to be lightly improved with the values of T2 and T100 increasing; after T2>0.47mm or T100>0.37mm, all fabric seam smoothness reaches the ideal target.

It should be noted that in Fig. 1 (3) the seam smoothness is to be more significantly improved along with the increasing of fabric surface thickness ST. It could mean that the seam smoothness

would be much more ideal provided that the fabric bulkiness was much higher. In the production of fabrics, selecting to use fiber with higher crimpness, properly reducing yarn twist or adopting less weaving points would efficiently improve the fabric bulkiness.



（1） （2） （3）

Fig. 1 Relationship between Fabric Thickness and Warp Seam Smoothness

Relationship between Fabric Formability and Warp Seam Smoothness. Fabric formability F referred to the joint results of fabric warp (or weft) elongation and the bending rigidity in the same direction; its calculation formula as follows:

$$F = \frac{(E20-E5)B}{14.7} \tag{1}$$

The relationship between sample warp formability F-1 and warp seam smoothness was shown in the form of scatter diagram as Fig. 2. Within the range of 0.3 mm^2>F-1>0.1 mm^2, the significant impact of the formability on fabric seam smoothness can not be observed; when the value of F-1 is more than 0.3mm^2, the warp seam smoothness shows a tendency to significantly improve.

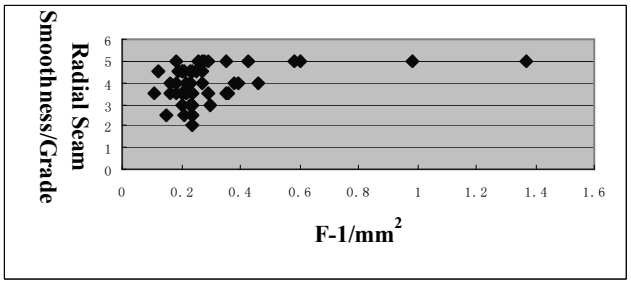
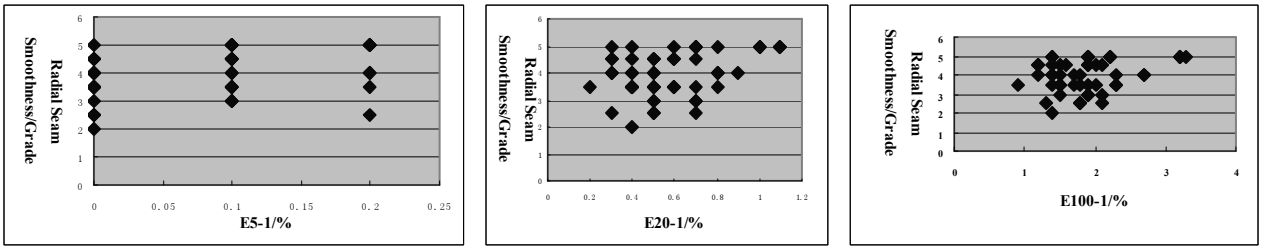


Fig. 2 Relationship between Sample Formability F-1 and Warp Seam Smoothness

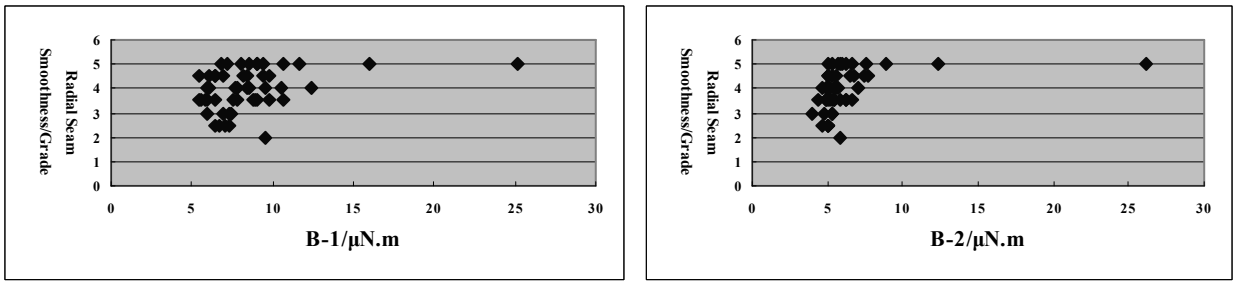
Relationship between Fabric Stretch-ability and Warp Seam Smoothness. Observing Fig. 3 (1) (2) (3), it shows that the impact of E5-1 on seam smoothness was not significant. They also showed that the seam smoothness could be significantly improved and the fabric seam smoothness would increase with increasing of E20-1 or E100-1 when E20-1≥0.8% or E100-1≥2.3%.



（1） （2） （3）

Fig. 3 Relationship between Fabric Extensibility and Warp Seam Smoothness

Relationship between Fabric Crimpness and Warp Seam Smoothness. Fig. 4 indicates the scatter diagram for the relationship between seam smoothness and fabric. With increasing of warp or weft bending rigidity, the fabric seam smoothness would be improved to some certain; when B-1 was more than 10.5μN.m or B-2 more than 6.3μN.m, the seam smoothness would become large with increasing of fabric bending rigidity.



（1） （2）

Fig. 4 Relationship between Fabric Bending Properties and Warp Seam Smoothness

Relationship between Seam Smoothness as well as Ambient Temperature and Humidity Conditions. In different ambient temperature and humidity conditions, see Fig. 5 for the change of seam smoothness for each fabric sample. With ambient air temperature and humidity in particular relative humidity (RH) increasing progressively, the grade of seam smoothness for sample usually tends to decrease. the reason for this is that all the samples for use in this study are pure wool yarn or mixed wool yarn fabrics, of which fibers, such as wool, cashmere, cotton, flax, silk and tencel, are of high moisture adsorption capacity. Such fibers absorb the water vapor molecules under certain air conditions, reducing fiber expansion and increasing fabric volume. At the time, the sewing thread of polyester didn't increase synchronously so that the wrinkle of fabric at seams and decrease of seam smoothness were caused. The decrease of seam smoothness at seams during storage and transportation of garment is caused by the change of relative humidity of ambient air. This would result in reducing the appearance quality and affecting sales of garments.

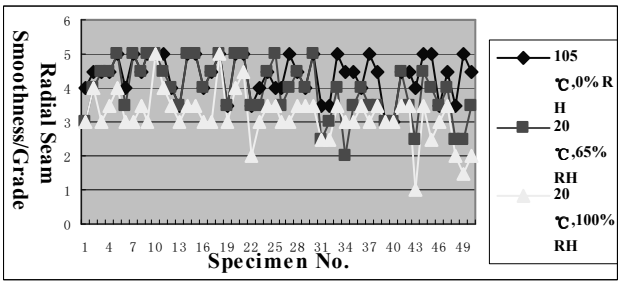


Fig. 5 Relationship between Seam Smoothness and Temperature and Humidity Conditions

Summary

This study explored the relationship between mechanical properties of worsted suit fabrics and warp seam smoothness, while it studied the effects of environmental air temperature and humidity on seam smoothness of samples. For light-thin to mid-thick worsted fabrics, their warp seam smoothness rating were related to fabric's structural mechanical properties, tensile mechanical properties, bending mechanical properties and formality properties. The increasing of fabric thickness and bulkiness was helpful to improve sewing properties; if the fabric extensibility was too

lower, it would be bad to improvement of sewing properties; if the fabric bending rigidity increased, it would be good to improve sewing properties; the more higher the fabric formality value was, the more ideal the sewing properties was. Increasing relative air humidity is reducing the seam smoothness rating. By such conclusions, enterprises producing worsted fabrics would be facilitated to further improve their textile process, in particular post-finishing process.

The paper selected two enterprise's fabrics as studied objects and discovered an evident difference between results by contrasting the test data. This further demonstrated the close relationship between the rating of garment seam smoothness and the post-finishing process of fabric. Owing to the narrow range of sampling fabric, this paper doesn't conclude the limited value of mechanical properties of worsted fabrics, which would have an effect on seam smoothness. In future, this study will go forward thoroughly by expanding the selection range of wool fabrics, for purpose of more comprehensive results.

Acknowledgements

Financial support for this work was provided by the Social Development Plan Project of Jiangyin Municipality (2009-26).

References

[1] H. Ni: Relationship between Seam smoothness and Sewing Conditions of Worsted Fabric Journal of Textile Study Mar. (2008), p. 80

[2] K. Liu: Establishment of Objective Evaluation System for Suit Seam smoothness Rating Based on Fabric Mechanical Properties.China Doctor Dissertation Full-text Database,2005-07-08[2007-03-10].http//www.cnki.net

[3] H. Ni: Study on the Seam smoothness of Fabric Based on Specification of Experiment Fabric. Wool Textile Journal Dec. (2008), p. 45

[4] Y.H. Pan, F. Bao and Sh.T Wang: A Fuzzy Evaluation System of Garment Seam smoothness Based on Improved RBF Network. Journal of Textile Study Mar (2008),p. 76

[5] Y.M. Li and W.Y. Zhang: Prediction of Seam Pucker Based on Grey Model. Journal of Textile Study Jun. (2008), p. 92

[6] Y.M. Li and W.Y. Zhang: Application of Wavelet Analysis in Evaluation on Seam Pucker of Fabrics. Journal of Textile Study Oct. (2009), p. 115