FABRIC HAND SEWABILITY CHARACTERIZATION

توصيف قابلية الحياكة بملمس القماش

El-Hadidy A., Mounir Hassan and Hamdy A.A. Ebraheem
Textile Department, Faculty of Engineering, Mansoura University

ملخص البحث:

يقدم هذا البحث دراسة عملية لتأثير عمليات التجهيز بالتبييض والصباغة على الخواص السطحية للأقمشة (الملمس وقابلية الحياكة) . وبنيت المقاييس العملية على قياس خواص الملمس للأقمشة بدلالة نسبة الإنسدالية ، وطول الإنثناء، بينما درست مقاييس قابلية الحياكة بدلالة مقاومة الأقمشة لاختراق إبرة الحياكة (قابلية الأقمشة للحياكة). وتم تقييم خاصية الملمس بتحديد قيم كل من أقصى قوة وكذلك الطاقة المبذولة لسحب عينات القماش خلال فتحة مخروطية الشكل. وقد وجد أن خواص القماش مثل طول الإنثناء ، ونسبة الإنسدال، والإستطالة، والملمس، وقابلية الحياكة، تقل بزيادة تركيز كل من البولى إيثيلين، ومطريات الأحماض الدهنية، وقد أظهرت النتائج ارتباطا عاليا بين قابلية الحياكة والملمس.

Abstract

This investigation presents an experimental study of the effect of bleaching-dyeing-finishing on fabric surface characteristics, i.e. Hand, tactile, and Sewability characterization Instrumental measurements was based on measuring fabric tactile properties as a function of, fabric drape ratio, and fabric bending length, while fabric Sewability was studded in terms of fabric resistance to needle penetration, i.e. fabric Sewability, and fabric hand was assessed by determination the values both of the maximum fabric pulled force and work done through a conical shaped funnel. It was found that, fabric properties such as: bending length, drape ratio, strength, extension, hand, and Sewability, decrease with the increasing the concentration of both polyethylene and Fatty Acids softeners. The obtained results has shown that correlations between fabric hand-tactile-Sewability are quite high.

Key word : Fabric Hand-Tactile-Sewability Characterization, Fabric Finishing.

1. Introduction

Fabric end uses can be roughly divided into technical (25%),apparel and household (75%). Fabrics for technical uses can be chosen on straight forward performance characteristics such as tensile strength, extension, and resistance to environmental attack. However, fabrics intended for clothing have less emphasis placed on their technical specification and more on their appearance and handling characteristics such as, luster, smoothness, stiffness and draping qualities. Handling the fabric is one of the ways of assessing certain of these properties "Handle", the term given to properties assessed by touch or feel, depends upon subjective evaluation of the fabrics by a person. Terms such as smooth-rough, Stiff-pliable, soft – hard, stretch – non starchy, spring – limp, compact – open, harsh-slippery, and warm-cool, depend strongly on the type of fabric being assessed, for in instance the smoothness of a wasted suiting is different in nature from that of cotton sateen. Because of the subjective nature of these properties attempts have been made over the years to devise objective tests to measure some or all of the factors that go to make up handle. This study focused on the objective evaluation of fabric handle.

The world-wide need for textile softening agents is huge. The

Accepted June 30, 2009.

application of softening substances turns a hard and brittle fabric into a soft, pleasant textile with which the buyer can expect a high degree of wearing comfort and wearing properties. The finisher plays a very important role as he sets the course for easy sewing in the garment industry. Sewing problems in the garment industry can be caused by the following topics in finishing, whereas the last two points to the softening process Steps [1,3]:

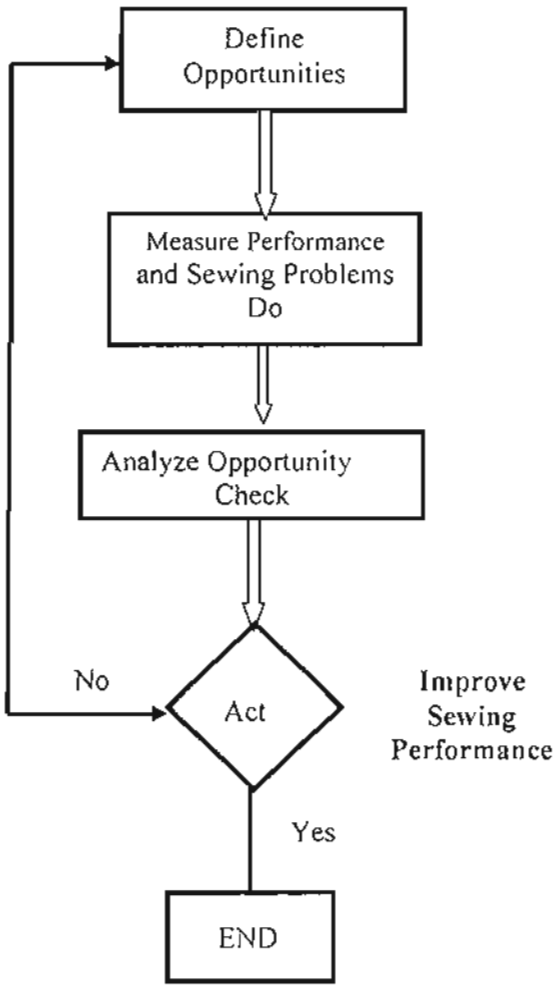
i. loss of strength/ DP due to bleaching and / or curing conditions being too strong.

ii. lack of the conditioning and thus not enough moisture content of the cotton (most difficult during cold winter months)

iii. wrong product selection, iv. not enough product add-on.

1.1. Objectives:

We have not demonstrate any hand method to be superior, assuming with general scientific opinion that there is no method that is superior in all situations. Instead we offer a new procedure to determine the hand-tactile-Sewability of a woven fabric treated with two different of softeners-as shown in the fig.1.



Ho hypothesis:

Fabric hand may be assess be by:

i) fabric tactile properties, and

ii) fabric Sewability assessment.

ANOVA, Regression, and Correlation Coefficients.

Sewability Control (SSS ↑ or ↓).

Tactile Properties control (Modulus ↑ or ↓).

Experimental Procedure:

Fig.1. Concept of this research.

1.2. Handle Measurement System.

In this measurement system, a conical shaped funnel used. This funnel is attached on Lloyd Tension-Tester. Sample used in this test cut circular in 15.5cm diameter. Fabric passes through the conical shape with an idea to fig.2 illustrates the handle testing sequence. This sequence can be described as follows [2]:

1. As the tensile m/c moves downward, the sample is moved upward against its own weight in a freely folding mode until it hits the internal surface of the funnel wide base at random points of the sample, determined only by the nature of free folding. When the sample touches the bottom circle of the funnel nozzle, form constrained drape takes place.
2. Upon touching the funnel internal surface, the sample begins to reconfigure and fold in a more organized manner as it is constrained by the conical shape of the funnel base.
3. When the sample center enters the funnel cylindrical nozzle, tension builds up as a result of the friction between the folded fabric sample and the entrance of the nozzle cylinder and the continuing constrained folding. This tension reaches a peak as the fabric surface attempts to enter to and realign with the internal surface of the cylindrical nozzle.
4. As Inside the sample becomes completely aligned with the nozzle cylinder, momentary drop in tension occur leading to profile trough.
5. Inside the cylindrical nozzle, a case of largely pure friction occurs between the points of the fabric that manage to remain on the surface during folding and the internal surface of the cylindrical nozzle.
6. Another tension build up may occur leading to another tension peak that is smaller than the initial tension peak.
7. As the fabric exit the cylindrical nozzle, a pressure release progressively occurs leading to a continuous reduction in tension.

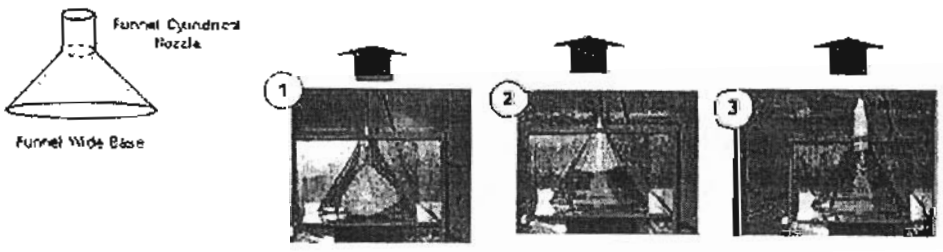


Fig. 2 Illustrate the handle testing sequence

In Fig.3 several parameters related to handle related comfort parameters are detected in order to analyze handle related parameters. These parameters are:

(i) maximum force, and (ii) the area under curve (work of rupture).

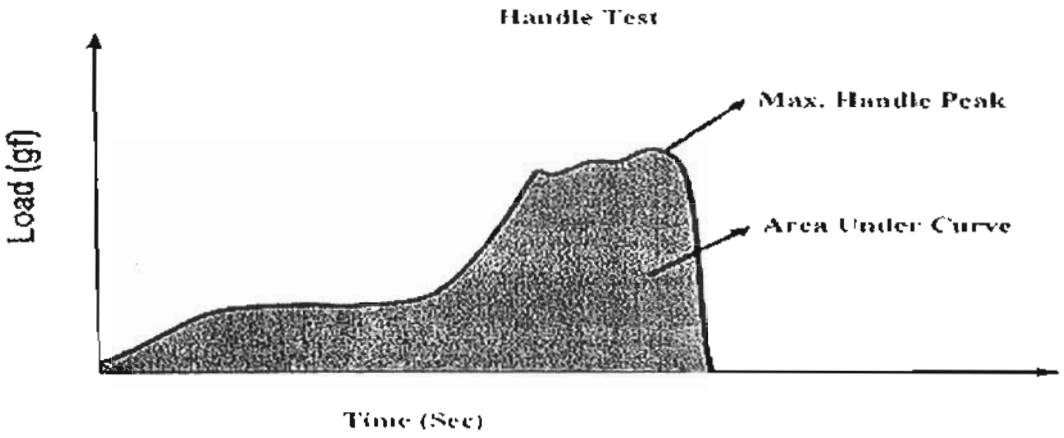


Fig.3 Fabric hand profile

2. Experimental and Computer Analysis

The experimental work of this study was divided into two main sections:

i. selection of tested materials, and
ii. experimental analysis of the mechanical properties of the selected fabric.

2.1. Fabrics:

A set of twill weave that were made from 100% cotton and dyed with adding two types of softener, which is Fatty Acid and Polyethylene with three concentration level 10 g/l and 20 g/l and 30 g/liter for the polyethylene softener (P1, P2, P3) and 10g/l, 30 g/l and 50 g/liter for the fatty acid softener(F1, F3, F5).

The specification of the fabric used is

*74*52 thread per inch/ 71*100 inch Twill 3/1, 270 g/m2.*

A set of pique knit fabric that were made to study the effect of bleaching and dyeing and finishing on fabric surface characteristics.

2.2. Softeners:

Softening a fabric simply means wearing the fabric fibers down, which is accomplished with heat, mechanical or chemical means, alone orin combination. Dyeing will soften (and pre-shrink) a fabric somewhat. Dyeing should always be done before softening, except perhaps in the case of mechanical methods. Often a day house will perform softening on fabrics as well. Whatever method used, manufacturers have noticed an increase of sales of softeners on hemp goods.

The effect of softeners on fabric Sewability-hand-tactile properties is inconclusive and contradictory in literature. It was found that " Fabric softeners may sometimes be effective in reducing fabric resistance to sewing needle penetration (fabric Sewability), since they lubricate the surface of the cloth and reduce the abrasive forces. On the other hand, they also promote the migration of fibers within spun yarns, especially synthetic fibers, So this technique is not always effective[3,4]

2.2.1 Fatty Acid Natural Lubricants.

General sense, natural dye bath lubricants enhance or promote fiber to fiber lubricity by lowering the coefficient of friction between the fiber and itself and fiber and metal. Fatty Acids are aliphatic carboxylic acid with varying hydrocarbon lengths at one end of the chain joined to terminal carboxyl (-COOH) group at the other end. The general formula is R- $(CH_2)_n$-COOH. Fatty acids are predominantly unbranched and those with even numbers of carbon atoms between 12 and 22 carbons long react with glycerol to form lipids (fat-soluble components of living cells) in plants, animals, and microorganisms. It is widely used as a lubricant and as an additive in industrial preparations. It is also used as a softener, accelerator activator and dispersing agent in rubbers.

2.2.2 Polyethylene Softener.

A nonionic polyethylene softener and lubricant highly recommended for denim finishing. It lends a very smooth hand at low dosage rates. It significantly reduces needle-cutting problems associated with denim.

2.3. Measuring Fabric Tactile Properties:

2.3.1 Bending length.

The relationship among the length of the overhanging strip, the angle that is bents to and the flexural rigidity "G", of the fabric is a complex one which was solved empirically by Peirce [5-6],

2.3.2 Bending modulus :

The stiffness of a fabric in bending is very dependent on its thickness, the thicker the fabric, the stiffer it is if all other factors remain the same. The bending modulus is independent of the dimensions of the strip tested so that by analogy with solid materials it is a measure of "intrinsic stiffness".

2.4. Drape:

Drape is the term used to describe the way a fabric hangs under its own weight. It has an important bearing on how good a garment look in use. In the drape test [7-BS5058], the specimen deforms with multi-directional curtain amount upon the shear properties of the fabric. The results are mainly dependent, however, on the bending stiffness of the fabric. The stiffer a fabric is, the larger is the area of its shadow the compared with the unsupported area of the fabric. The higher the drape coefficient the stiffer is the fabric.

2.5. Sewability Assessment.

Experimental Measuring of Needle penetration Torque (NPT):

The experimental measuring aim the researches was to get the best combination between needle and fabric and to measure the forces on these forces during sewing process [8]. An electronic circuit was built up to measuring the change of current intensity consumed on the servo motor as an indication to the change of the feeding and needling mechanical loads. The system of measuring is shown in Ref. [9,10,11 and 12]

2.5.1. Calibration procedure [10]:

Calibration was carried out by following steps:

i) measuring NPT.

ii) record the NPT result for 2,3,4,5, and 6 layers of paper.

iii) put a known weight on the needle rod until the needle penetrate the paper, this weight

will be equal to the corresponding voltage measured by the system [8],
iv) that step was repeated for 2,3,4,5,6 layers, and
v) plot the curve of real voltage versus the penetration force in (cN) for all the tested layers.

2.5.2. Specific Sewing Stress (cN/ tex) [11]:
A useful normalizing fabric Sewability and bringing them into relation with fabric properties is:

Specific Piercing Stress =

Fabric resistance to needle penetration per needle width (cN/mm) / Fabric weight (g/m2) (1)

This parameter is useful for comparisons of fabric, i.e. fabric Sewability.

3. Results and Discussion.

Figure 4 shows effect of softener type on the fabric strength in warp direction. It was found that, the fabric strength decreased with the increasing the concentration of the softener ANOVA test shows that the significant effect of changing the concentration of polyethylene softener is higher than the effect of changing the concentration of fatty Acids on the fabrics drape ratio, as shown Tables 1,2,3 and 4.

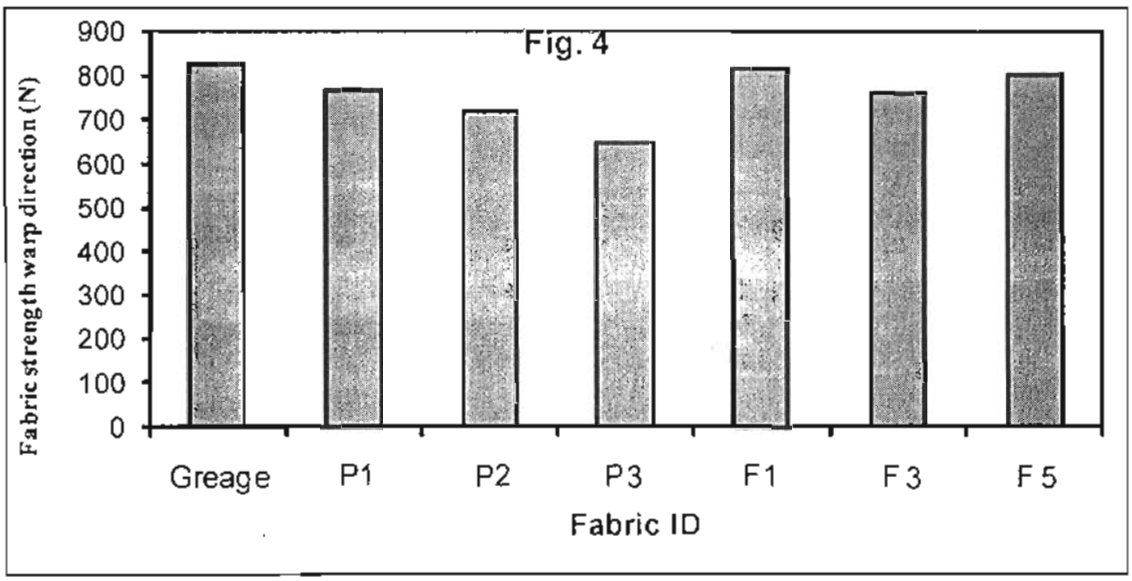


Table 1 Shows ANOVA Results (PET warp)

Property		Sum of Squares	df	Mean Square	F	Sig.
Fabric Strength	Between groups	48853.340	3	16248.45	6.9	0.013
In warp direction	Within groups	18887.770	8	2360.972		
Fabric Extension	Between groups	1.929	3	0.643	1.7	0.252
In warp direction	Within groups	3.1	8	0.388		

Table 2 Shows ANOVA Results of (FA).

Property		Sum of Squares	df	Mean Square	F	Sig.
Fabric Strength	Between groups	6242.55	3	2080.85	1.051	0.422
warp direction	Within groups	15840.50	8	1980.06		
Fabric Extension	Between groups	11.169	3	3.723	4.953	0.031
	Within groups	6.013	8	0.752		

Table 3 Shows Results of ANOVA (PET waft).

Property		Sum of Squares	df	Mean Square	F	Sig.
Fabric Strength In weft	Between groups	43989.93	2	21994.96	06.841	0.001
	Within groups	4916.79	6	819.466		
Fabric Extension In weft	Between groups	2.746	2	1.373	0.674	0.031
	Within groups	12.213	6	2.063		

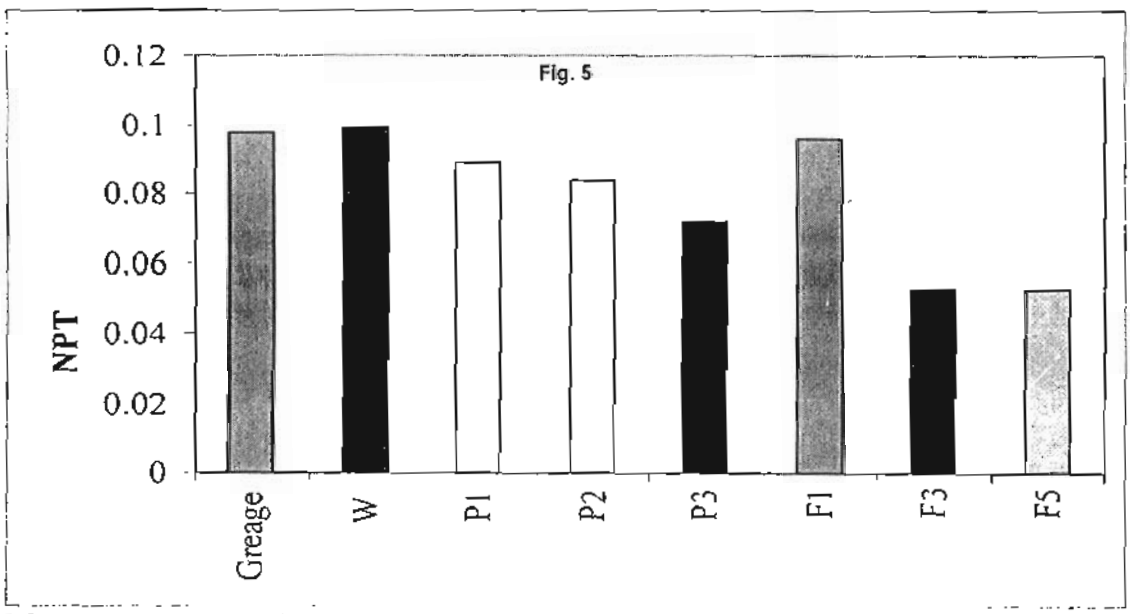
Table 4 Shows Results of ANOVA (FA weft).

Property		Sum of Squares	df	Mean Square	F	Sig.
Fabric Strength In weft	Between groups	62714.327	3	20904.776	19.739	0.001
	Within groups	8472.493	8	1059.062		
Fabric Extension In weft	Between groups	18.543	3	6.181	4.412	0.41
	Within groups	11.207	8	1.401		

Also, it was found that ANOVA test shows that the significant effect of changing the concentration of Fatty Acids softener is higher than the effect of changing the concentration of polyethylene softener on the fabric extension in warp direction. Similar results was shown in weft direction.

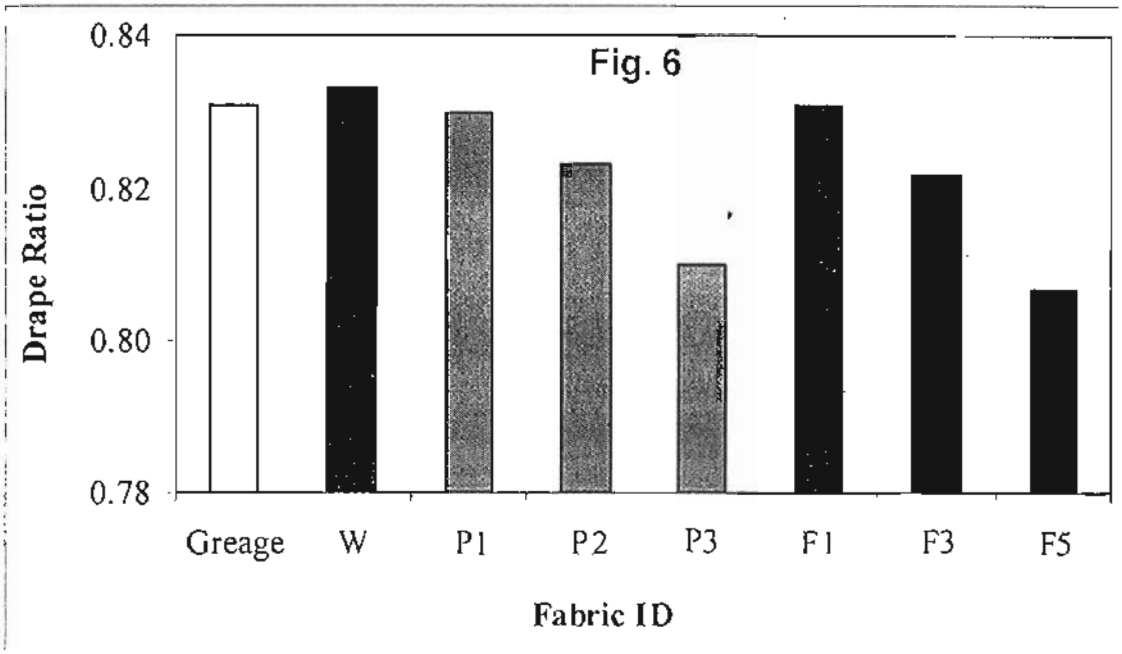
3.1. Effect on Sewability:

Figure 5 shows effect of softener type on fabric resistance to sewing needle penetration force (fabric Sewability). The fabric Sewability parameter decreased with increasing the concentration of both polyethylene and Fatty Acids softeners.



3.2 Results of Fabric Drape Ratio:

Fig.6 shows the effect of softener type on the fabric drape ratio. The drape ratio decreased with increasing the concentration of the softness.



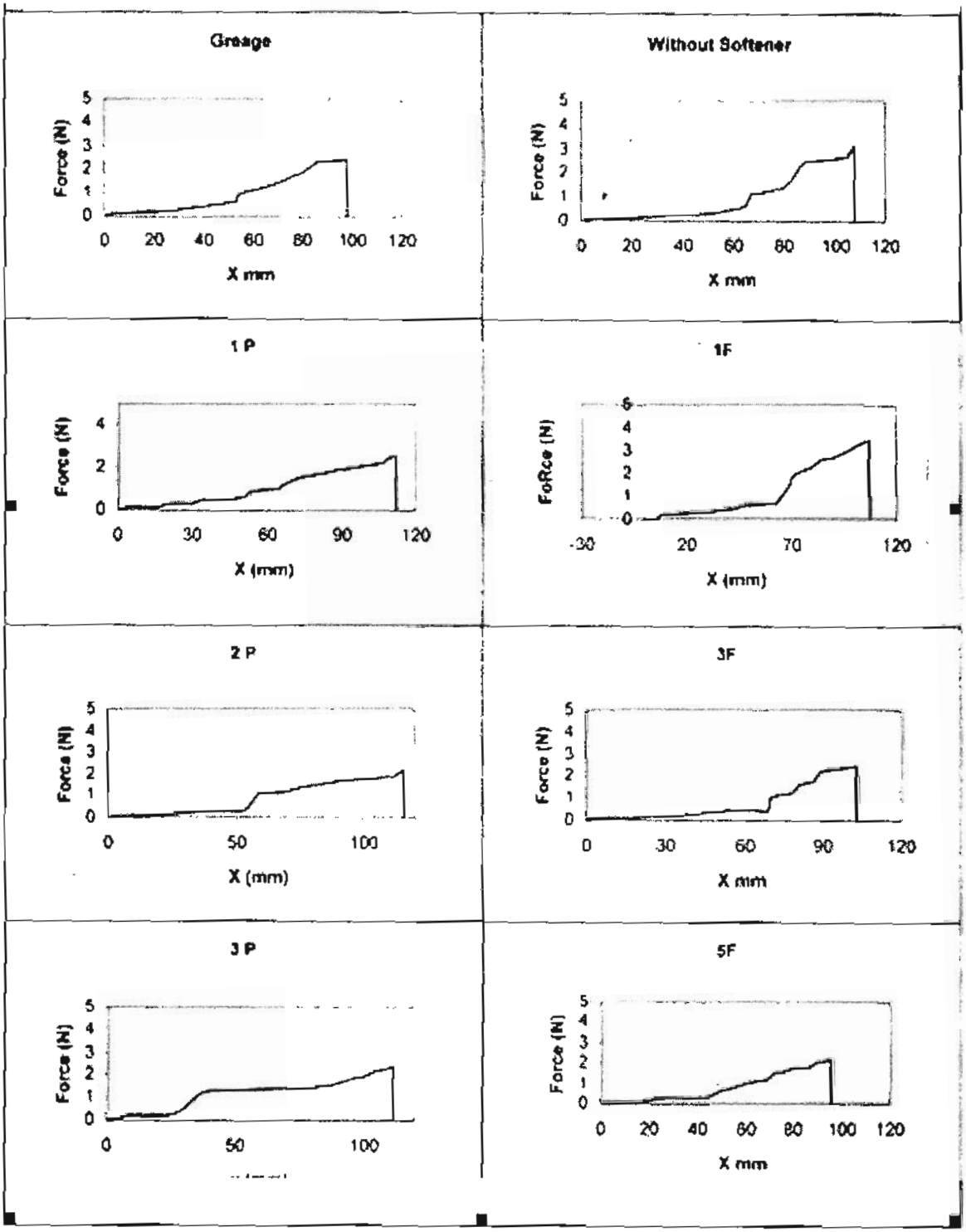
3.3. Results of Fabric Hand:

Table 5 shows effect of softener type on the fabric hand Hand Results. The maximum force deceased with increasing the concentration of both polyethylene and Fatty Acids softeners Table 5 Fabric.

Table 6 shows the correlations and nonparametric correlations between fabric Hand – Sewability – Tactile parameters.

Table 5 shows effect of softener type on the fabric hand Results.

Treated Fabrics	Force (max.)	Work of Rupture	Treated Fabrics	Force (max.)	Work of Rupture
Greage	2.44	973.869	Greage	2.44	973.869
W	3.17	1095.490	F1	3.51	1470.723
P1	2.56	1221.558	F3	2.9	1378.379
P2	2.2	1005.699	F5	2.21	813.279
P3	2.37	1304.251			



Figs. 7 shows the force displacement curves for different fabrics pulled through funnel

Table 6 Fabric Hand-Sewability-Tactile Characteristics:

Properties / Treated Fabrics	Fabric Hand					Fabric Sewability		Fabric Tactile					
	Force (max.) N		Work Done.		X_1			Drape Ratio		Bending Length			
	(N)	(-)	(gf.cm)	(-)		NPT	X_2		X_3	Warp	Weft	Mean	X_4
Grange	2 44	0.84	973 9	0.55	0.68	0.097	0.55	0.86	0.94	2.99	2.42	2.70	0.99
W	3.17	0.74	1095.9	0.54	0 63	0.099	0.54	0.83	0.97	3.33	2.43	2.88	0.94
P1 (10 g/l, PET)	2.56	0.67	1221.6	0.60	0.63	0.089	0.60	0.83	0.97	3.50	2.23	2.87	0.95
P2 (20 g/l, PET)	2.2	0.81	1005.7	0.061	0.72	0.084	0.63	0.84	0.96	3.13	2.30	2.72	0.99
P3 (30 g/l, PET)	2.37	0.62	1304.3	0.74	0.68	0.072	0.74	0 81	1	3.10	2.29	2.70	1
F1 (10 g/l, FA)	3.52	0.55	1470.2	0.55	0.55	0.096	0.55	0 90	0.9	3.20	2.58	2.89	0 93
F3 (30 g/l, FA)	.9	0.59	1378 4	1	0 77	0.053	1	0 84	0.96	3.34	2.38	2.86	0.95
F5 (50 g/l, FA)	2.21	1	813.3		1	0.053	1	0.81	1	3.25	2.29	2.77	0.98

It was found that tested fabric properties such as bending length, drape ratio, Strength, extension, hand, and Sewability, decrease with the increasing the concentration of both softeners. So, based on the foregoing, it can be concluded that, the relationship between fabric hand and fabric tactile properties in nonlinear and coefficient of correlation "r" reaches 0.71, and between fabric hand and fabric Sewability reaches 0.87, and lastly between fabric tactile and fabric Sewability reaches 0.42, as shown in Figs. 8,9, and 10. Here too it is clear that the correlation is positive and good since the value of the correlation coefficient amounts to 0.667 as a average.

Using linear regression the regression line was found:

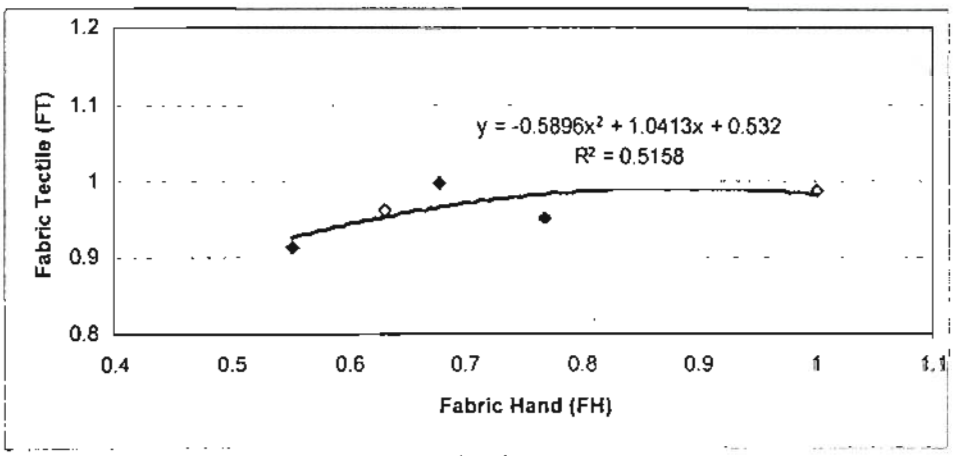


Fig. 8

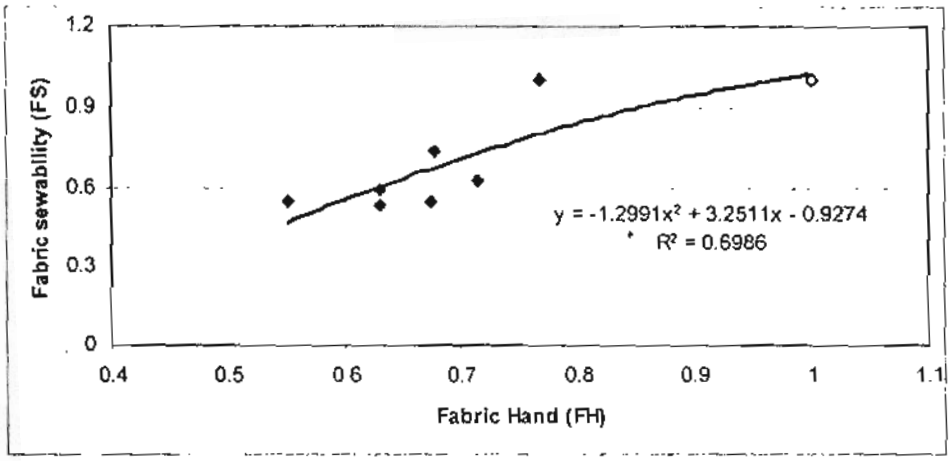


Fig. 9

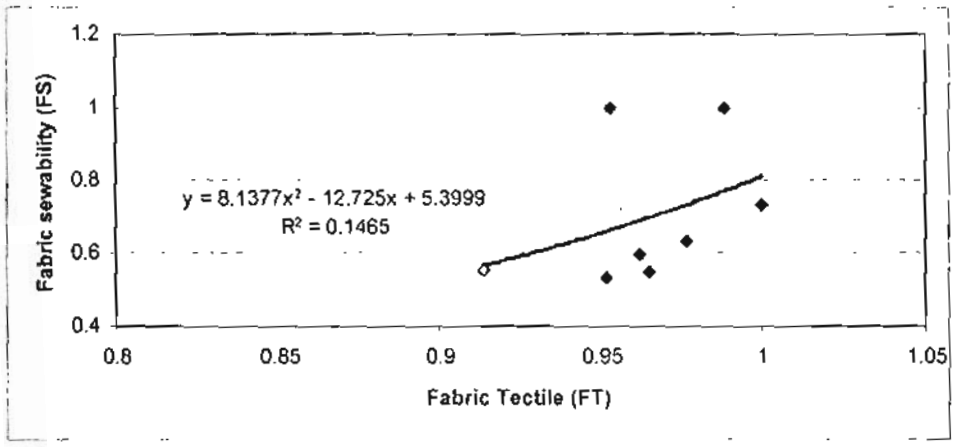


Fig. 10

4. Conclusion.

The sum total of all wet processing desizing, scouring, bleaching, dyeing and finishing with softeners steps will impact the final hand-Sewability-tactile of tested fabric. The results this study on the hand-Sewability – tactile of 100% cotton fabrics show that softener type has a great influence on the geometric, mechanical, and appearance properties. Softeners are lubricants that provide functional properties as well as hand – Sewability – tactile qualities. From a physical property point of view, they improve tensile strength and reduce fabric resistance to sewing penetration (fabric Sewability) i.e. sewing without problems. Softeners are functional finishes that have the greatest impact on fabric hand-tactile-Sewability. It is evident, that correlation between fabric hand-tactile-Sewability in range 0.42-0.87 with average of 0.67, i.e. there is a good correlation between fabric hand-tactile – Sewability.

References

[1] Zyschka, R.: Textile softeners and their tricky application, CHT R. Beitlich GmbH, Tubingen (www.daw.com/ethyl/app/fabric.htm)

[2] mouir Hassan, PhD. Thesis "Computer-Based System for Evaluation and Recognition of the Structural and Surface Characteristics of fabrics " textile engineering, Mansura University (2004)

[3] Smith, B.F. and I. Block: (1982) Textiles in perspective, Prentical Hall, Englewood Cliffs, N.J.1982

[4] Peirce, F., T., The handle of cloth as a measurable quantity, Text, Just, 1930,21,T377

[5] Bs 5058 Method for the assessment of drape of fabric.

[6] Cusick, G.,E., The resistance of fabrics to shearing forces, Tex. Jnt. 1961, 52T.395.

[7] Saville, B.P., Physical Testing of Textiles, The Textile Institute, Wood head Publishing, CRC, 1999, USA.

[8] Mohamed, A., D. (2004): Study the effect of fabric and sewing machine parameters on the dynamic behavior of sewing, MSc. MSc. Tex. Eng. Dept., Mansoura university, 2004.

[9] El-Hadidy, A. (2006) : Fabric Roughness-Sewability characterization, proc. 13rd International conference " STRUTEX, Technical University, Librec, 27-29 Nov. 2006, CZ.

[10] El-Hadidy, A. and El-Deeb, A.,(2005): Sewability engineering of technical fabric, proc. International Conference, Technical university of Ostrava, C2

[11] El-Ghandour, N. (2005): Sewability Assessment, PHD , thesis, Tex. Eng. Dept. Mansoura University, 2005.

[12] El-Hadidy, A. et. Al: (2007) Overall Sewability Assessment, Research project, Tex. Eng. Dep., Mansoura university, 2007.