

Sewability of Denim fabric before and after finishing

قابلية أقمشة الجينز للحياكة قبل و بعد التجهيز

Ihab El-Sayed^{1,2}, Salah Mansour³, Ahmad El-Sheikh⁴

¹Suez Canal University, ²Taibah University, ³Agriculture Research Center, ⁴Helwan University,

خلاصة:

يختبر هذا البحث خواص القابلية للحياكة لأقمشة الجينز قبل و بعد عمليات تجهيز مختلفة متضمنة المعالجة بالانزيمات. حيث يقوم البحث بدراسة العلاقة بين قوة اختراق إبرة الحياكة لأقمشة الجينز و المقاسمة بواسطة جهاز قياس القابلية للحياكة المعروف باسم (L & M Sewability Tester from Godrich) بالخواص المختلفة للأقمشة و مدى ارتباطها إحصائياً مع نتائج الجهاز. حيث تم استخدام ثلاثة أوزان مختلفة من الأقمشة الجينز تم فحصها قبل التجهيز و بعد التجهيز و المعالجات المائية المختلفة. تم عمل تحليل للنتائج إحصائياً و منها تحليل مدى ارتباط نتائج جهاز الاختبار القابلية للحياكة مع وزن المتر المربع للقمائن و سمك للقمائن و العديد من خواص الأقمشة الأخرى. تمت مناقشة النتائج و تحليلها بناء على معاملات الارتباط التي تم الحصول عليها. حيث ثبت أن المعالجات المائية المختلفة تؤثر على قوة اختراق الإبرة.

Abstract

This paper examines the Sewability properties of the Denim Fabric (Jeans Fabric) before and after different wetting processes including enzyme treatment.. The aim of this paper is to study the needle force penetration (NFP) of the Denim fabrics using the L&M Sewability Tester (LnMST). In this research paper three different weights of Denim fabrics with several wetting processes were investigated. The NPF from LnMST were correlated to Denim Fabric weight per square meter, Denim Fabric Thickness and many other fabric properties. The coefficient of correlation and the results were analyzed and discussed. It was proofed that the wetting processes affect the jeans fabric properties significantly and the correlation with (LnMST) is relatively high

Key Words: Denim Fabric, Jeans Finishing, Sewability, Needle Force Penetration, Fabric Airpermeability

Introduction

Textile and Garment industry are in a continuous challenges with market demands and pressure. Dye on Demand (DOD), Just In Time (JIT), Quick Response (QR), Environmental Friendly Products (Oeko-Tex®), Cleaner Production , Total Quality Management and all these terms represent a pressure on textile industry and textile manufacturer as well as Pollution Prevention (PP) in textile industry with focuses on Denim industry in Egypt. It is well known that Denim fabrics are growing market and developed market. Since it is a high

dynamic market with a great demand for a widely range of customer with continuously demanding for new fashion styles and fashion trends including washing and dyeing (Tie Dyeing for example). The textile manufacturer is trying to achieve the required fashion with the most economic way. Some are concerning only with price, but the exporting markets are facing a severe condition and requirement to conform with in order to penetrate the export market¹, these area mainly Oeko-Tex® conformance. The finishing and wet process method of the denim fabric determines the setting of the sewing machine in the garment factory. The high dynamic market of the

continuously changing fashion demand in the denim require the garment factory to be capable of changing their setting and configuration² of sewing machines in order to cope with the newly developed finished fabric. The term sewability is getting great attention and care inside all garment factories. The sewing process is considered one of the critical processes in textile chain in terms of Quality Assurance. Assuring a high quality seam in the garment piece is a complex task. It starts from finishing of fabric and ends with machine setup.

Objectives

In this paper we introduced the proposed believed method to be the most economic and environmental friendly method for producing fashionable denim with emphasize on sewability problem. Also among the objectives of this research paper is to help manufacturer in planning the sewing process as well as pre-wetting process. The authors tried to present the optimum treatment (not damaging the fabric and the environment and achieve the desired fashion with minimum problem in sewing garment and production) for denim fabric. The authors studied the sewability of the resulted treatment using the L&M Tester for measuring the needle penetration force of the fabric sample used before wetting processes and after processes. The Authors intends to use the results of this research paper as an off line tool for sewing process planning.

Material and Methods

Material

The authors built their experiment and research on a group of selected Denim fabrics used commonly by majority of garment manufacturers in Egypt. Three different weights of denim fabric namely (302,397,463 g/m²) were used. The Denim fabric was produced by 100% cotton yarns Ne 28/1 in warp and 28/1 in weft. Fabric structure used were twill 2/1, warp density 27 and weft density 21.

Methods

The samples were treated with several wetting processes. These processes were mainly applied as follows: washing , washing and fashion, washing and stone wash, washing and balanced enzyme - washing and acid enzyme, washing and balanced enzyme and chlorine, washing and acid enzyme and chlorine, washing and balanced enzyme and potassium permanganate, washing and acid enzyme and potassium permanganate. All the above mentioned wet treatments were applied only to simulate the industrial processes, but the authors must emphasize here that they are disagree completely with the treatments which doesn't conform with international environmental agreements (Oeko-Tex®). The authors applied those treatment for the purpose of the research and to prove and indicate the difference and impact of each treatment on the sewability of the fabric. In other words to tell the garment manufacturer that some treatment are not necessary and doesn't help in improving the sewability.

Wet Process

The fabric washed using 1g/l Amylase Enzyme and 1g/l Detergent for 15 minutes at 60°C. The fabric were washed with water for 5 minutes at ambient temperature. Before going to sewing process the fabric were immersed in a softener solution with concentration 100g/l softener and 0.5 g/l acetic acid.

The rest of wet processes were carried out according to the recommendation of some traditional garment manufacturer in order to simulate the effect of wet treatment in the research laboratory.

Weight L and Weight M and Weight H are as follows: 302,397,463 g/m²

Testing fabric properties

The following tests were performed on the fabric according to international standards:

1. Weight of fabric grams per square meter A.S.T.M. Standard D 3776.
2. Measuring of fabric thickness. (ISO 5084).
3. Surface Water Absorption (ASTM D-4772-97)
4. Fabric crease recovery BS EN 22313 (ISO 2313).
5. Fabric Stiffness BS 3356
6. Determination of abrasion resistance of fabrics BS 5690
7. Air Permeability of Textile Fabrics A.S.T.M. Standards D 737-96.
8. Tensile Strength A.S.T.M. Standards D 5034-95

The L&M Sewability Tester

The L&M Sewability Tester⁴ has been developed to give a standard reproducible test for sewability, i.e. a test which will indicate to



the clothier whether any supplied fabric is capable of being sewn without difficulty. The information supplied by the machine is not subject The L&M Sewability Tester enables consecutive readings of force for penetration of the fabric by a selected needle to be measured on a small sample of fabric at a rate of 100 penetrations/min. Using a threshold figure high counts are

recorded when the threshold is exceeded.

L&M Tester –Needle Size

18 Metric or 16x231 International

110 System

Thirty denim fabric samples were numbered according to its weight and wetting treatment applied to it and was sent to the Central laboratories in the Textile Consolidation Fund in Alexandria Egypt, and samples were tested three times for averaging after instrument average (L&M Sewability Tester).

The samples were ranked according to table 1.

Results and Discussion

The maximum values for (L), (M) and (H) were from LnMST :

Average	49	91	78
Max	83	145	109
Min	32	60	55
Range	51	85	55

Fusing and or bursting of fabric due to speed of needle and heat generated due needle movement.

Figure 1 to figure 4 show the way of needle penetration and the force acting on from the fabric

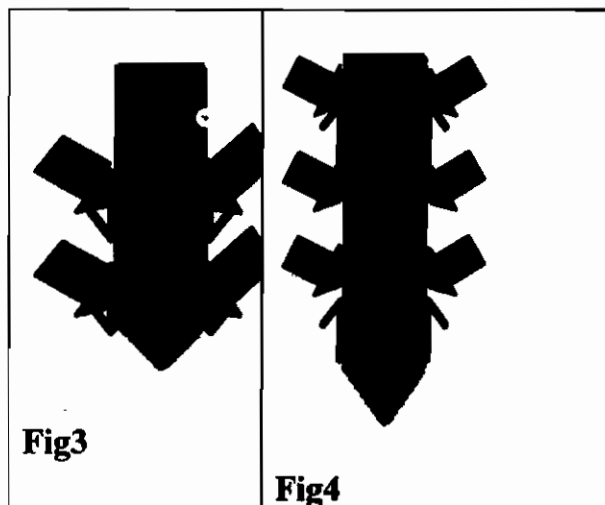
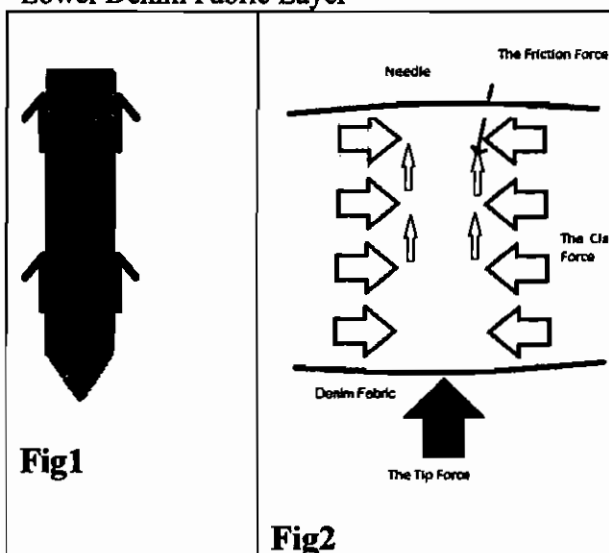
Lateral Force from Denim Fabric

Represented by black arrows

Upper Denim Fabric Layer

Same like above

Lower Denim Fabric Layer



Results

A correlation was drawn using the NPF and Fabric weight, Fabric Thickness, Fabric stiffness, Fabric Crease Recovery, Fabric Drape ability, Fabric Tenacity, and other fabric properties.

Discussion

The L& M Tester was used to measure the Needle Force Penetration (NFP) in grams. The force which resist needle from the fabric was logged on a computer using a sensor fitted on the needle and connected to an analog to digital converter who deliver the data to computer.

Figure 1 , shows that the group of light (l) weight fabric lying in the bottom of the graph (diamond), with values range from 35-80 grams. While the group of medium (m) weight fabric are lying in the middle of the graph (square) with values range from 44-87 grams. Finally the group of heavy (h) weight fabric are lying in the top of the graph (triangle) with values range from 49-90 grams.

The minimum values for (l), (m), (h) are 35,44,49 and maximum values are 80,87,90 respectively.

Weight 1 and Weight 2 and Weight 3 are as follows: 302,397,463 g/m²

The average values of NFP was 52.4, 70.6, 71.7 g according to L&M Tester results of the samples.

This results proves that L&M Tester is capable of reading and differentiating between fabric weights per square meters.

Correlations coefficients between Needle force penetration and fabric properties. Effect of finishing treatments on tensile strength and elongation% of the denim fabrics. The tensile strength and elongation% values of the denim fabrics were recorded. The data obtained shows that the value of tensile strength of the raw materials was greater than the values of samples treated by washing then followed by the washing and neutral enzymatic and then washing and acid enzyme treatment. This is due to the effect of decreasing cellulose binding. Effect of finishing treatments on the crease recovery angle on the denim fabrics . Results obtained in Fig. shows the crease recovery angle values for the denim fabrics. It has been noted that the washing followed by the neutral enzymatic treatment has the greatest values compared with the other treatments. This is due to the occurrence of the sewability of the cellulose fibers which decreases the cellulose binding and then improve this fiber to return to its origin form.

Analysis

The raw fabric (l), (m), (h) are having relatively high values of needle force penetration namely 66,82,87 respectively. After washing the samples the needle force penetration for the fabric reduced by 47% and 24% for l and h respectively.

When adding Neutral Enzyme during the washing process, NFP was reduced by 47%, 21% and 10% for l, m and h fabrics respectively.

While adding Acidic Enzyme during the wash process, NFP was reduced by 27% for the l fabric and by 23% for the h fabric and increased by 5% for the m fabric.

Adding Chlorine and Neutral Enzyme reduced NFP by 13% and 33% for m and h respectively.

Adding Chlorine and Acidic Enzyme reduced NFP by 42%, 46% and 44% for l, m and h respectively.

Washing and Fashion reduced NFP by 38% and 11% for l and m respectively.

Washing and stone reduced NFP by 39% and 2% for l and m respectively while increased by 3% for h fabric.

Wash by Neutral Enzyme and adding permanganate increased NFP by 26% for l fabric.

Wash by Acidic Enzyme and permanganate increased NFP by 21% for the l fabric while NFP was reduced by 4% and 9% for m and h fabric respectively.

The following table shows the averages of the NFP for l,m,h respectively

Fabric / item	L	m	h
NFP (g)	52.4	70.6	71.1
g/m2	302	397	463
NFP ratio	1	1.347328	1.35687
g/m2 ratio	1	1.31457	1.533113

Conclusion

The L & M Sewability Tester results(of the light weight fabric) which represent Needle Force Penetration were compared with the Denim Fabric physical and mechanical properties. The highest correlation obtained was between LnMST and Denim Fabric Crease Recovery in the negative direction. The second highest correlation was with fabric surface water absorption. Similar high correlation figure came fabric stiffness and fabric air permeability. This research proofs that enzyme treatment of jeans is the most suitable for denim fabric with better sewability and less damage of

the fabric. The medium weight fabric has a different fabric structure. The weaving design twill is more tight than light weight fabric fabric. The twill design of the other two samples (light weight and heavy weight) are having different fabric design. L & M Sewability tester is not a reliable tester for Denim Fabric. Fabric Treatment will affect NFP. There are three possibilities for needle of the L&M Tester to lie on a yarn crossing of warp and weft, secondly will lie between

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Fabric Property	Light Fabric Wt (L)	Medium Fabric Wt (M)	Heavy Fabric Wt (H)
Fabric Weight (Wt) g/m ²	302.7	397.52	463.73
Yarn Count Ne - Warp	40/1	28/1	24/1
Yarn Count Ne - Weft	36/1	24/1	16/1
No. Warp ends / cm	28	27	25
No. Weft ends / cm	21	18	18
Fabric Structure	Twill 2/1	Twill 2/1	Twill 2/1
Material	100% Cotton	100% Cotton	100% Cotton

Table1

Sample Nr			Finishing Treatment	Test Nr.
Weight (L)	Weight (M)	Weight (H)		
1	2	3	Raw Material	1/1 > 3
4	5	6	Wash	2/1 > 3
7	8	9	Wash + Neutral Enzyme	3/1 > 3
10	11	12	Wash + Acidic Enzyme	4/1 > 3
13	14	15	Wash + Neutral Enzyme + Chlorine	5/1 > 3
16	17	18	Wash + Acidic Enzyme + Chlorine	6/1 > 3
19	20	21	Wash + Fashion	7/1 > 3
22	23	24	Wash + Stone	8/1 > 3

Table2

Fabric Finishing Status	Sample Nr.		Sample Nr.		Sample Nr.	
	Weight (L)	NFP	Weight (M)	NFP	Weight (H)	NFP
Raw Material	1	83	2	145	3	109
Wash	4	53	5	106	6	72
Wash + Neutral Enzyme	7	41	8	84	9	90
Wash + Acidic Enzyme	10	32	11	90	12	76
Wash + Neutral Enzyme + Chlorine	13	41	14	60	15	62
Wash + Acidic Enzyme + Chlorine	16	46	17	72	18	54
Wash + Fashion	19	47	20	97	21	77
Wash + Stone	22	50	23	73	24	86

Table3

Fabric Property	Light Weight	Medium Weight	Heavy Weight
Thickness mm	-0.72505	-0.48219	-0.19348
Surface water absorption cm	-0.97754	-0.85817	-0.57868
Crease Recovery	-0.98081	-0.88964	-0.57086
Stiffness mg/cm	0.956679	0.846886	0.651188
Air Permeability	-0.80765	-0.96428	-0.77572
Weft count/cm	-0.94949	-0.88083	-0.69988
Loss in weight %	-0.8485	-0.92075	-0.66657
Warp Tensile strength Kg	0.829261	0.830262	0.739263
Weft Tensile strength Kg	0.668337	0.826105	0.706553

Table 4