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# STRETCH FABRICS IN LEATHER MANUFACTURING: PERFORMANCE PROPERTIES OF STRECH LEATHERS

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***Abstract:*** *Product variability of manufactured leather goods such as garment leathers could be closely related to the wear comfort because each material forming the garments are affected the comfort properties of the products. Considering the significant demand to elastic woven stretch fabrics and the advantages provided to leather goods like allowing easy body movements, well-fitting and keeping the shape make the use of stretch fabrics focus in interest. In this study, the performance properties of stretch leathers, leathers and spandex fabrics were presented and the differences between the characteristic properties of the leathers were described. For this purpose, physical characteristics of leathers were investigated in terms of thickness, weight, drape ability, stiffness, bending stiffness, air and water vapor permeability. The drape ability, stiffness and bending stiffness properties were significantly affected by the stretch fabrics laminated on the suede side of the leathers. The drape ability, stiffness and bending values were increased due to the implementation of stretch fabrics. There was no significant difference between the air permeability values of the leathers prior and after the implementation of stretch fabrics in contrast to water vapor permeability. The results of this study showed that the aesthetic behavior of clothing materials such as drape and stiffness properties as well as water vapor permeability was mainly affected from the implementation of the stretch fabrics.*

***Key words:*** *stretch, leather, physical characteristics, drape ability, bending behavior*

## 1. INTRODUCTION

In recent years, consumers are more conscious and selective about clothing materials. Their expectations are increasing in time due to the fast development of technology, continuous change in fashion and also the product variability of manufactured goods [1]. Especially challenging working conditions, long working hours, business travels and also social activities drive consumer demands for comfortable clothing materials. Bahadir et al., 2015 was defined the comfort of the clothing material as the satisfaction and feeling the balance of a person inside the wear material and environmental conditions [2].

Nowadays, the interest for woven fabrics including elastane is quite high due to the advantages provided to the clothing materials. The wear materials including elastane or in other words stretch or spandex fabrics allow easy body movements; they fit well to body, maintain their shape during the usage and provide considerable comfort in wear [3].

Elastic yarns and fabrics have played an important role in the world textile industry and a great effect on comfort and functionality of the clothing materials [4]. Elastic yarns can be used with all natural and synthetic fibers. In order to provide the desired comfort in clothing materials, 2-5% of spandex is sufficient to use in the mixture of the fibers. The stretch fabrics seem similar in appearance, touch and performance to the non-stretch ones. These fabrics have characteristic properties such as comfort, elasticity and resilience. A clothing material consisting of spandex can be stretched in ratio of 25-35% and right after the removal of the cloth, it can return to its original shape [3].

The elastic or spandex fibers can be also used with the leather goods by implementing the stretch fabrics on the suede side of the leathers. The application of the stretch fabrics to garment leathers is mostly focus in interest nowadays especially for the outwear materials.

Leather goods provide many unique properties to consumers like heat insulation, comfort, softness, water vapour and air permeability etc. In addition, the aesthetic behavior of the leather clothing materials like drape ability becomes focus in interest [5, 6]. Lojen and Jevsnik 2007 explained that a drape of a fabric is related to the mechanical properties of fabric such as bending, shear, formability, weight and thickness [7]. Also Frydrych et al., 2000 revealed that drape is also related to rigidity [8]. In addition, it should be considered that mechanical properties will be the indicator to determine the behavior of the fabrics [9].

In contrast to textile material, leather is not homogeneous substance due to its production from individual skins [5, 10]. Besides, characteristic properties of the leathers are differed depending on the region of the leather like neck, shoulder, croupon and belly. Also, different leather types have different physical and chemical properties and they have different surface appearances. Lastly, the eating habits of the animals, environment, age, sex, and the tanning procedures are the other reasons of the leather inhomogeneity [11].

In this study, the performance properties of stretch leathers, leathers and stretch fabrics were presented and the differences between the characteristic properties of the leathers were described. In the literature survey, few studies were found on the subject of mechanical, aesthetic and the biaxial stretching properties of the leather material [5, 10, 11]. Up to date, no study was found about the description of the aesthetic and performance properties of stretch and non-stretch leathers. For this purpose, physical and aesthetic characteristics of leathers and fabric were investigated in terms of thickness, weight, drape ability, stiffness, bending stiffness, air and water vapor permeability.

## 2. MATERIAL METHOD

### 2.1 Material

Eight domestic sheep garment leathers were used in the study. The tanning process of the leathers was performed by chromium. Half of the leathers were laminated with spandex fabric while the other half was the control group.

### 2.2 Method

Sampling of the leathers for all tests was performed according to TS EN ISO 2418 standard. The test samples were conditioned in accordance with TS EN ISO 2419, at 23 ± 2°C temperature and 50% ± 5 relative humidity [12,13].

The thicknesses of test samples were measured according to TS 4117 EN ISO 2589 standard by using Satra-Thickness gauge [14].

Drape coefficient was determined using drape tester according to TS 9693 [15]. The drape coefficient was expressed as a percentage. A circular leather specimen of 30cm diameter was sandwiched between two horizontal discs of smaller diameter (18cm), and the unsupported annulus of leather and fabric were allowed to hang down. The draped specimens were taken the picture by a cam. The pixels of pictures of draped materials were count. The drape coefficient was calculated with the formula (1):

$$\text{Drape coefficient (DC \%)} = [(M - S) / (L - S)] \times 100 \quad \textbf{(1)}$$

M: Material Pixels Count
S: Small Diameter Pixels Count
L: Large Diameter Pixels Count

Flexural or bending rigidity was determined according to ASTM D1388 by Shirley Fabric Stiffness Tester [16]. A rectangular strip of fabric was supported on a horizontal platform of the stiffness tester and extended in the direction of its length, so that an increasing part was over hanged and bended under its own mass. When the tip of the specimen was reached a plane passing through the edge of the platform and inclined at an angle of 41.5° below the horizontal, the bending length was read off the scale. Bending rigidity in the horizontal and vertical directions is calculated using the formula given below (2):

$$G = 0.1 \times W(gr) \times C^3 \quad \textbf{(2)}$$

where:
G = bending rigidity, mg.cm,
W = material mass per unit area, $g/m^2$,
c = bending length, cm.

Material bending rigidity was calculated by the mean values of horizontal and vertical bending rigidities (3).

$$G_{material} = (G_{vertical} \times G_{horizontal})^{½} \quad \textbf{(3)}$$

SDL Atlas Digital Pneumatic Stiffness Tester was used for the softness of the materials according to ASTM D4032 [17]. A plunger of 25.4 mm diameter pushed the fabric through a 38 mm diameter orifice for a distance of 57 mm (2.25 in) in 1.7 seconds and the maximum forces were recorded.

The air permeability test was performed according to the TS 391 EN ISO 9237 using Textest FX 3300 Air Permeability Tester [18]. The test was repeated 10 times in all areas of the leathers under 400Pa pressure with $20cm^2$ diameter ring.

The water vapor permeability values of the leathers were determined in accordance to TS EN ISO 14268 [19].

## 3. RESULTS AND DISCUSSION

The thickness, weight, drape coefficient, bending rigidity, stiffness, air and water vapor permeability properties of stretch garment leathers, non-stretch garment leathers and spandex fabric were determined and the results were shown in Table 1.

Garment leathers combined with spandex fabric were found thicker and heavier than the non-stretch leathers and spandex fabric (Table 1) due to the two-fold application of spandex fabric on the suede side of the leathers.

The values of average drape coefficient were determined as 28.9 to 62.52% for non-stretch and stretch leathers respectively. The stretch leathers had the highest values while the lowest drape coefficient was found from the non-stretch ones. When the opposite correlation was considered between the drape coefficient and drape ability, it was normal to found out that non-stretch leathers had the most drape ability than the stretch leathers and spandex fabric.

The mean values of bending rigidity for non-stretch and stretch leathers were found as 5.09 and 95.95 mg/cm, respectively. The spandex fabric applied to the suede side of the leather was directly affected the aesthetic properties of the leathers such as drape ability and bending rigidity. After the impregnation of the spandex fabric, bending rigidity was increased. Von Hoven et al. (1999) explained that higher values of bending rigidity indicate greater resistance to flexing whilst lower values indicate easier flexing and hence better drape ability. Krishnaraj et al., 2009 also found out that the correlation between the average bending rigidity and drape coefficient was excellent and the drape coefficient values were inversely related to the softness values.

The softness of leathers was assessed traditionally by hand evaluation and subsequently by compression methods. In the softness tester [21], the softness values are measured by the distention of leather when a constant load is applied perpendicular to the surface of the leather [5]. In order to determine the softness values of the leathers, stiffness test was performed to the leather samples in this study and determined that the stiffness values were ranged from 0.92 to 13.32 N. Stretch leathers had the highest stiffness that was an indication of the firmness property.

***Table 1:*** *The performance and aesthetic properties of the spandex fabric, stretch and non-stretch leathers.*
*L: chromium tanned leathers, L+S: chromium tanned leathers combined with spandex fabric, S: spandex fabric, (M): Mean

| * | Thickness (mm) | Weight ($g/m^2$) | Drape coefficient (DC %) | Bending rigidity (mg.cm) | Stiffness (N) | Air permeability ($m^3/m^2/min$) | Water vapor permeability ($mg/cm^2.h$) |
|---|---|---|---|---|---|---|---|
| L-1 | 0.49 | 189.43 | 24.30 | 5.27 | 1.32 | 0.33 | 0.027 |
| L-2 | 0.46 | 197.39 | 31.66 | 6.09 | 1.67 | 0.16 | 0.029 |
| L-3 | 0.53 | 195.67 | 28.87 | 6.40 | 1.62 | 0.24 | 0.025 |
| L-4 | 0.58 | 186.38 | 30.75 | 8.72 | 1.45 | 0.26 | 0.026 |
| **L (M)** | **0.52** | **192.22** | **28.90** | **6.62** | **1.52** | **0.25** | **0.027** |
| L + S -1 | 1.00 | 395.97 | 61.15 | 78.32 | 10.62 | 0.22 | 0.005 |
| L + S -2 | 0.84 | 424.97 | 56.38 | 81.84 | 10.72 | 0.25 | 0.03 |
| L + S -3 | 1.03 | 424.26 | 61.46 | 98.35 | 12.50 | 0.21 | 0.001 |
| L + S -4 | 1.13 | 458.48 | 71.07 | 125.30 | 19.42 | 0.30 | 0.0004 |
| **L + S (M)** | **1.00** | **425.92** | **62.52** | **95.95** | **13.32** | **0.24** | **0.01** |
| **S (M)** | **0.30** | **114.22** | **41.17** | **5.09** | **0.92** | **242.40** | **-** |

The air permeability results of the spandex fabric were found significantly higher than the stretch and non-stretch leathers. When the air permeability values of stretch and non-stretch leathers were compared, it can be seen that similar test results were obtained on which we could reveal that the spandex fabric had no significant effect on the air permeability properties of the leathers.

In contrast to air permeability results, spandex fabric had a negative impact on water vapor permeability results of the leathers. The water vapor permeability results of the stretch leathers were found nearly half of the non-stretch leathers.

Table 2 showed that the values of thickness, weight, drape coefficient, bending rigidity and stiffness properties of non-stretch leathers, stretch leathers and spandex fabric had a significant correlation and a consistent relation.

The air permeability gave different correlation values than the other properties (Table 2). The correlation value between air permeability and thickness was found -0.7420 which demonstrated the lower thickness values led higher air permeability results.

***Table 2:*** *The correlation between the performance and aesthetic properties.*

| Properties | | Correlation Values |
|---|---|---|
| Drape coefficient (DC %) | Thickness (mm) | **0.7768** |
| Drape coefficient (DC %) | Weight (g/m2) | **0.8187** |
| Drape coefficient (DC %) | Bending rigidity ( mg.cm) | **0.9273** |
| Drape coefficient (DC %) | Stiffness (N) | **0.9163** |
| Bending rigidity ( mg.cm) | Thickness (mm) | **0.9560** |
| Bending rigidity ( mg.cm) | Weight (g/m2) | **0.9741** |
| Bending rigidity ( mg.cm) | Stiffness (N) | **0.9996** |
| Stiffness (N) | Thickness (mm) | **0.9639** |
| Stiffness (N) | Weight (g/m2) | **0.9800** |
| Air permeability | Thickness (mm) | **-0.7420** |
| Air permeability | Water vapor permeability | **0.0015** |
| Water vapor permeability | Thickness (mm) | **0.6693** |

In addition, the correlation between the bending rigidity/drape coefficient, and bending rigidity/stiffness was significant and determined as 0.9273 and 0.9996 respectively.

## 5. CONCLUSIONS

In this study, characteristic properties of spandex fabric, stretch and non-stretch leathers fabric were investigated in terms of thickness, weight, drape ability, stiffness, bending stiffness, air and water vapor permeability and following conclusions have been drawn;

1. The drape ability, stiffness and bending stiffness properties were significantly affected by the stretch fabrics laminated on the suede side of the leathers.
2. The drape ability, stiffness and bending values were increased due to the implementation of stretch fabrics.
3. There was no significant difference between the air permeability values of the leathers prior and after the implementation of stretch fabrics in contrast to water vapor permeability.
4. The results of this study showed that the aesthetic behavior of clothing materials such as drape and stiffness properties as well as water vapor permeability as a performance characteristic was mainly affected from the implementation of the stretch fabrics.

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