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# MAPPING THE VARIATIONS OF TENSILE STRENGTH OVER THE AREA OF SHEEPSKIN LEATHER

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***Abstract:*** *Leather is not a uniform material from a structural perspective. The physical properties of leather change depending on the animal type and the animal individually. Furthermore these properties vary depending on the position and direction of sampling over its area. The aim of this study was to measure some physical properties of garment sheepskin leathers over the whole areas and then draw strength maps to provide information for cutting of leathers for garment production. For this aim, surface area of 10 chromium tanned nappa sheep leathers have been sampled with standard press knife of tensile strength into 2147 samples. 5 leathers were sampled perpendicular and the other 5 leathers were sampled parallel to the line of backbone of sheep skins. Thickness, tensile strength, elongation at break values for each sample has been measured and recorded. Then strength maps were drawn by using MATLAB (Matrix LABoratory) software that allows matrix manipulations, plotting of functions and data. The findings showed that the strength and stretch properties change directionally and locational over the area of the leather, the strength decreased gradually while moving away from the line of backbone to the edges and the areas around kidneys were weaker than the areas around neck.*

***Key words:*** *Leather, Sheepskin, Garment, Tensile Strength*

## 1. INTRODUCTION

To begin with, leather is a sheet material with the area of each piece ranging from tens of square centimetres to six, seven or more square meters depending on the animal from which it was obtained. Until the development of woven textiles it was the only material available in sheets of this size [1].

However leather is not a uniform material from a structural perspective. The physical properties of leather change depending on the animal type and the animal individually. Furthermore these properties exhibit variations in different parts over the leather area.

Leather is anisotropic material, its fibre bundles reportedly being oriented in different directions depending on the location on the skin and the animal from which it originated [2,3]. This difference in direction of fibre bundles reportedly affects some physical properties such as ultimate tensile strength, and accounts for some of the variability observed in properties of finished leather [2].

The strength of leather varies so widely in different parts of the skin as to make recorded values meaningless if the location of the test piece is not indicated [4].

The scientific and commercial significance of variations in strength and stretch in leather has been discussed by Daniels considering the works of Wilson and Swaysland [5, 4, 6]. The studies were based on calf skins and hides. However there is not any information available on sheepskins, which are an important material for garment leathers.

Producing garments from leathers have significant differences than textiles. Leather is a specific material showing different touch, elasticity, drape, strength, etc. properties of its own. The garments are made up of many patterns, because area and physical properties of leather are not uniform. Placing patterns on leathers and cutting are also more difficult than textile. A certain number of leather batch is sorted for a garment, the patterns are placed considering physical properties of leathers, where the pattern will be used and the form of the garment [7].

The aim of this study is to measure some physical properties of garment sheepskin leathers over the whole areas and then draw strength maps to give information to for cutting of leathers for garment production.

## 2. MATERIAL AND METHOD

### 2.1 Material

- 10 chromium tanned sheepskin leathers obtained from a company producing leathers for garment manufacture
- Hydraulic press and press knives for cutting leather specimen
- Satra-Thickness gauge for thickness measurement of leathers,
- Shimadzu AG-IS Tensile Tester and Trapezium-2 software for testing physical properties,
- MATLAB R2011a software for drawing maps of strength

### 2.2 Method

Physical properties of leathers represent some variations related to humidity and temperature [8]. Leather samples have been conditioned at 23±2°C and 50±5% relative humidity for 48 hours and the tests were carried out at the same conditions according to TS EN ISO 2419 standard [9].

The thicknesses of leather samples have been measured with SATRA Thickness Gauge according to TS 4117 EN ISO 2589 standard [10].

The tensile strength and percentage of elongation of leather samples have been measured by using Shimadzu AG-IS Tensile Tester and Trapezium-2 software according to TS EN ISO 3376 standard [11].

The samples were cut by using a standard press knife with the dimensions shown in Fig. 1.

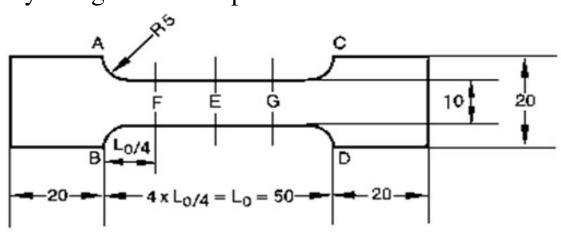


***Fig.1:*** *Dimensions of press knife used for tensile strength*

The samples were taken perpendicular to the line of backbone from 5 leathers and parallel to the line of backbone from the other 5 leathers as shown in Fig. 2 and Fig.3. [Wilson].

***Fig.2:*** *Perpendicular sampling*

***Fig.3:*** *Parallel sampling*

***Table 1:*** *Leather codes and their sampling direction, areas and number of samples*

| LEATHER CODE | SAMPLING DIRECTION TO BACKBONE | LEATHER AREA ($dm^2$) | NUMBER OF SAMPLES |
|---|---|---|---|
| A | Perpendicular | 70 | 228 |
| B | Perpendicular | 70 | 216 |
| C | Perpendicular | 71 | 195 |
| D | Perpendicular | 62 | 193 |
| E | Perpendicular | 80 | 243 |
| F | Parallel | 71 | 209 |
| G | Parallel | 83 | 257 |
| H | Parallel | 80 | 225 |
| I | Parallel | 72 | 205 |
| K | Parallel | 63 | 176 |

The tensile strength was calculated with the formula (1):

$$Tensile\ Strenght = \frac{Breaking\ load\ (N)}{Area\ of\ cross\ section\ (mm^2)} \quad (1)$$

Each sample was coded regarding to its position over the leather area and the tensile strength data was entered into MATLAB spreadsheet cell according to its original position. Then the maps of strength were plotted by using the "Plot Catalog" function in MATLAB.

## 3. RESULTS AND DISSCUSSIONS

The minimum, maximum and mean values of thickness, tensile strength, elongation% and maximum force during break measurements for the samples taken perpendicular and parallel to the line of backbone are given in Table 2 and Table 3 respectively.

***Table 2:*** *Thickness, Tensile Strength, Elongation % and Max. Force of perpendicular samples*

| LEATHER | | Thickness (mm) | Tensile Strength ($N/mm^2$) | Elongation % | Max. Force (N) |
|---|---|---|---|---|---|
| A | Min | 0,37 | 2,53 | 22,66 | 10,36 |
| | Max | 0,53 | 21,68 | 82,99 | 97,56 |
| | Mean | 0,45 | 9,09 | 50,53 | 40,46 |
| B | Min | 0,35 | 2,38 | 33,39 | 12,36 |
| | Max | 0,58 | 22,69 | 90,55 | 95,30 |
| | Mean | 0,47 | 7,66 | 62,20 | 36,20 |
| C | Min | 0,38 | 3,41 | 30,22 | 15,36 |
| | Max | 0,58 | 20,26 | 93,96 | 106,20 |
| | Mean | 0,45 | 9,76 | 57,83 | 44,46 |
| D | Min | 0,35 | 4,17 | 28,57 | 15,84 |
| | Max | 0,52 | 18,46 | 95,89 | 77,75 |
| | Mean | 0,43 | 10,47 | 57,94 | 44,81 |

| | | | | | |
|---|---|---|---|---|---|
| E | Min | 0,38 | 2,43 | 36,79 | 10,47 |
| | Max | 0,59 | 25,48 | 91,62 | 122,32 |
| | Mean | 0,46 | 9,66 | 57,26 | 44,56 |
| Mean of Perpendicular Samples | Min | 0,37 | 2,98 | 30,33 | 12,88 |
| | Max | 0,56 | 21,71 | 91,00 | 99,82 |
| | Mean | 0,45 | 9,33 | 57,15 | 42,10 |

***Table 3:*** *Thickness, Tensile Strength, Elongation % and Max. Force of parallel samples*

| LEATHER | | Thickness (mm) | Tensile Strength ($N/mm^2$) | Elongation % | Max. Force (N) |
|---|---|---|---|---|---|
| F | Min | 0,34 | 3,44 | 31,29 | 14,10 |
| | Max | 0,57 | 11,82 | 155,99 | 57,91 |
| | Mean | 0,45 | 6,69 | 85,06 | 30,68 |
| G | Min | 0,35 | 5,52 | 40,12 | 20,57 |
| | Max | 0,57 | 19,06 | 150,46 | 91,65 |
| | Mean | 0,48 | 11,69 | 74,15 | 56,58 |
| H | Min | 0,32 | 5,34 | 32,24 | 22,41 |
| | Max | 0,62 | 20,37 | 134,32 | 106,67 |
| | Mean | 0,44 | 11,15 | 65,65 | 49,49 |
| I | Min | 0,33 | 3,42 | 28,96 | 12,66 |
| | Max | 0,50 | 21,39 | 159,79 | 85,56 |
| | Mean | 0,41 | 10,66 | 78,02 | 43,35 |
| K | Min | 0,27 | 4,87 | 30,57 | 14,42 |
| | Max | 0,50 | 18,47 | 142,99 | 77,62 |
| | Mean | 0,42 | 8,61 | 71,62 | 36,62 |
| Mean of Parallel Samples | Min | 0,32 | 4,52 | 32,64 | 16,83 |
| | Max | 0,55 | 18,22 | 148,71 | 83,88 |
| | Mean | 0,44 | 9,76 | 74,90 | 43,34 |

When the data of Table 2 and 3 is compared, it is seen that the mean thickness of leather samples are almost the same being 0.44-0.45mm. That has to be expected because the leathers have been supplied from a garment leather producing company from the same batch.

There is a significant difference in elongation %. The mean elongation percent of parallel samples are % 74.9 and bigger than the mean elongation percent of perpendicular samples, which is % 57.15.

The directions of maximum and minimum stretch in the area now recognised as the "Official Sampling Position" (OSP) run respectively parallel and perpendicular to the backbone. However across the rest of the hide the direction of minimum and maximum values varies. The maximum values run more or less in the direction of the hair follicle, as this roughly follows the direction of the underlying fibre structures. This is indicated in Fig.4. [5]

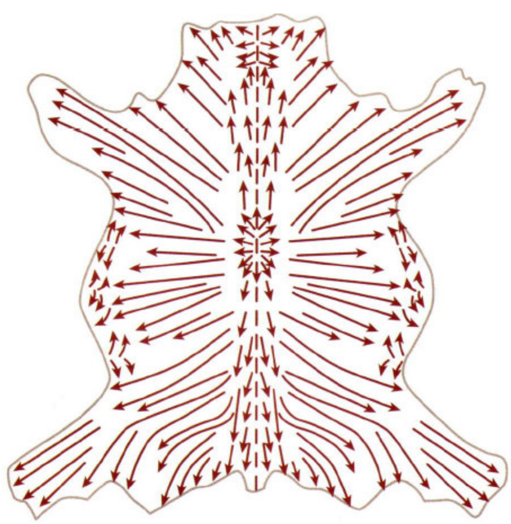

***Fig.4:*** *The direction of the hair follicle approximately follows the underlying fibre direction*

The findings for the elongation % can be used in pattern cutting of garment leathers. The patterns which will be used in moving parts of the body such as arms, elbows, etc. and will be subject to elongation during usage can be placed parallel to the backbone line of sheepskins and the patterns which needs less elongation can be placed perpendicular to the backbone.

The mean tensile strength values of perpendicular and parallel samples show only a little difference, being the perpendicular samples' values slightly lower. However the variations in tensile strength values are remarkable. The mean tensile strength values varies in the range of 2.98-21.71 $N/mm^2$ and 4.52-18.22 $N/mm^2$ for perpendicular and parallel samples respectively. This means 4 to 7 multiple times strength variations over the area for the same leather. Acceptable quality standards recommended by United Nations Industrial Development Organization (UNIDO) for chromium tanned garment leathers are 10 $N/mm^2$ for tensile strength [12]. So, the same leather can meet or fail the quality standards depending the region of sampling. The standard for sampling location (TS EN ISO 2418) determines the standard sampling region for leathers [13]. But, even for a leather which can pass the tests, its week areas can fail the quality. Fig.5 and Fig.6 shows the maps of tensile strength values over the area of whole sheep skin leathers.

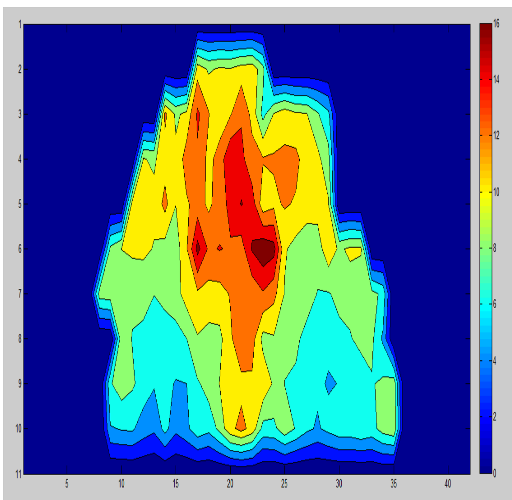

***Fig.5:*** *Map of strength of perpendicular samples*

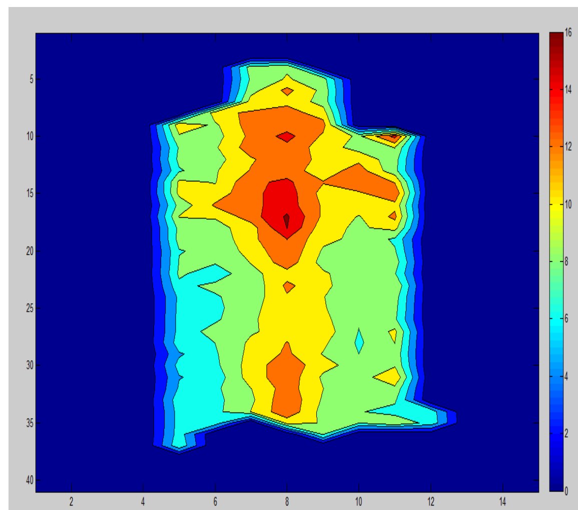

***Fig.6:*** *Map of strength of parallel samples*

## 4. CONCLUSIONS

- The leather is an anisotropic material, the strength and stretch properties change directionally and locational over the area of the leather
- The strength is not even over any very large area
- The strength is highest close to the backbone line of leathers
- The strength decreases gradually while moving away from the line of backbone to the edges
- The areas around kidneys are weaker than the areas around neck
- These maps can give an aspect for the leather cutters and leather garment producers

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