PHYSICAL-MECHANICAL PERFORMANCES OF STEERING WHEEL COVER LEATHERS IN SPECIAL CONDITIONS

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Abstract: The steering wheel is among the important components of a vehicle, through it having full control over its direction. It is made of a metal base covered with a polymeric material. To improve the look and feel of a steering wheel, usually it is covered by leather. Choosing the material for covering the steering wheel must be done responsibly, because depending on the material, it can generate a certain type of comfort when using the steering wheel. Thus, the current work aims to evaluate the durability and wear resistance of different types of leather coatings used in automotive steering wheels. A series of tests were performed on leather samples before and after exposing them to special conditions (high\low temperature, humidity, UV) like tensile strength and elongation, tear strength, tear load, surface softness, color fastness and flex resistance. All the tests were performed according to actual standards in ICPI accredited laboratory. The results of the experiment showed that the durability and wear resistance of the leather varied significantly depending on the type of coating. Overall, the study provides valuable insights into the characteristics of different types of leather and can help future research involved in developing more durable and long-lasting steering wheel cover leathers.

Keywords: steering wheel cover leather, physical-mechanical tests, special conditions

1. INTRODUCTION

The steering wheel industry has evolved significantly over the years, with advancements in technology, design, and materials [1]. Traditionally, steering wheels were made from materials such as wood or metal. However, with the advent of new materials such as leather, synthetic materials, and carbon fiber, steering wheel designs have become more diverse and sophisticated. The industry has seen a trend towards customizability, with manufacturers offering a wide range of options for drivers to choose from. This includes different shapes, sizes, colors, and materials, allowing drivers to personalize their driving experience [2].

Steering wheel durability is a critical consideration, as a worn or damaged steering wheel cover can compromise safety and detract from the vehicle's overall appearance [3].

This durability depends on several factors, including the quality of the leather, the tanning process used, and the frequency and conditions of use. High-quality leather that is tanned using a reputable process can provide excellent durability, resisting wear and tear from constant use.

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Leather steering wheel covers that are exposed to sunlight, extreme temperatures, or moisture can degrade faster than those that are kept in more controlled environments [4].

Some manufacturers offer special coatings or treatments on the leather to enhance its durability. For example, a protective coating can be added to the leather to prevent it from fading or becoming discolored over time. Additionally, some steering wheels may feature a perforated design that improves breathability and helps prevent moisture buildup, which can also extend the leather's lifespan [5-7].

Nowadays, the best leather for steering wheel is considered to be napa. Napa leather is a type of high-quality leather that is known for its softness, durability, and luxurious feel. It is made from the skin of calves, lambs, or goats, and is named after the Napa Valley in California, where it was first produced in the early 1900s. The process of making napa leather involves using a full-grain leather hide that has been tanned with a vegetable-based solution. This tanning process helps to preserve the natural grain and texture of the leather, while also making it more resistant to water, stains, and scratches. The leather is then buffed and sanded to create a smooth, even surface that is free of imperfections. One of the defining features of napa leather is its softness and suppleness. This is achieved through a process called milling, which involves tumbling the leather in a large drum with water and other materials to soften it and give it a more pliable texture. The result is a leather that is extremely comfortable to the touch and molds to the shape of the body. Napa leather is often used to make high-end products, such as luxury car interiors, high-end furniture, and designer handbags. It is also used in the production of high-end leather jackets, shoes, and accessories. One of the benefits of napa leather is its durability. The tanning and milling processes that the leather undergoes help to make it more resistant to wear and tear, and it is also more resistant to water, stains, and scratches than other types of leather. This makes it an ideal material for products that are used frequently and need to withstand daily use. Another benefit of napa leather is its versatility. It is available in a range of colors and finishes, including glossy, matte, and metallic, which makes it a popular choice for a wide range of products. It is also easy to maintain and can be cleaned with a damp cloth and a mild soap [8-12].

Young goats' leather, which is obtained by tanning goat hide, is considered one of the finest leathers in the world. Besides its softness, it is also known for its flexibility, strength and durability, which makes it proper for all kinds of applications in the fashion industry. In terms of appearance, goatskin has a tight grainy texture, distinctive for this type of leather. The natural properties of goatskin allow it to be not only soft and supple, but also water resistant. Compared to other animal leather, goat leather is not stiff, due to the presence of lanolin produced by the goat's skin.

Depending on preferences, there are available as steering wheel covers assortments of natural leather with a corrected face, as well as perforated leather [2].

There are also situations in which artificial leather is preferred, although will never have the properties of natural leather, which is known for its ability to regulate temperature and absorb moisture, making it a popular choice for high end steering wheels, shoes, clothing, and accessories that come into direct contact with the skin. Regarding the aesthetic part, leather is known for its unique texture, color, and grain patterns, which are determined by the animal from which it was derived.

2. EXPERIMENTAL SETUP

2.1. Materials and Methods

The objective of this study was to evaluate the physical-mechanical differences of various natural leathers that are usually used in the manufacture of steering wheel covers, as well as their behavior in different conditions. Five types of leathers were subject to physical-mechanical tests, according to actual standards, performed in ICPI accredited laboratory, as follows: Determination of tensile strength and percentage elongation SR EN ISO 3376:2020, Determination of tear strength SR EN ISO 3377-1:2012, Tests for color fastness. Color fastness to cycles of to-and-from rubbing EN ISO 11640, Tests for color fastness. Color fastness to perspiration EN ISO 11641, Determination of flex resistance by flexometer method EN ISO 5402-1, Determination of softness EN ISO 17235 using Softness tester ST300. These parameters were measured before and after exposing the samples to special conditions, like high/low temperature, increase humidity and UV light, to simulate natural conditions that can occur during the usage of steering wheel covers. Also, colorimetric measurements were made before and after 24 hours of UV irradiation with a device that measures CieLab parameters, DS-220 spectrophotometer.

The macroscopic images of the five samples are presented in Figure 1. They were chosen based on the usual preferences of customers. Are coded as follows:

A. dark brown napa leather.
B. black goat leather.
C. vegetal tanned leather.
D. leather with applied surface.
E. perforated napa leather.

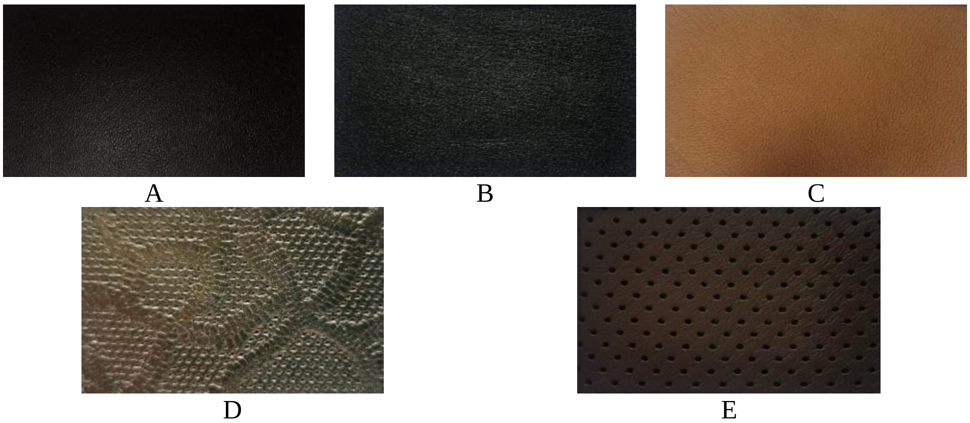

Fig. 1. Photographic images of:
A - dark brown napa leather; B-black goat leather; C-vegetal tanned leather; D- leather with applied surface; E-perforated napa leather.

3. RESULTS AND DISCUSSION

The obtained results from physical-chemical tests before exposing the samples to various conditions are summarized in Table 1.

Table 1. Initial results of physical-mechanical properties of the five leathers.

Properties	Sample				
	A	B	C	D	E
Thickness, mm	1	1.1	1.2	1	1.2
Elongation at 10 N, %	3.9	4.4	5.1	5.9	6.1
Elongation at crack, %	41.1	44.1	33.3	37.6	40.1
Elongation at break, %	57.2	58.3	38.1	39.2	44.3
Tensile strength at crack, N/mm^2	14.1	16.8	11.4	13.5	8.9
Tensile strength at break, N/mm^2	16.2	17.5	12.1	13.8	9.7
Single edge tear load, N	58.6	56.2	36.4	18.1	20.1
Color fastness*:					
Dry	5/5	4/5	5/5	5/5	4-5/5
Wet	4-5/5	4/4	5/5	4-5/5	4-5/5
To perspiration	4/5	4/4	5/5	4-5/5	4/5
Flex resistance	>150000	>150000	>150000	<150000	>150000
Softness, 20 mm ring	3.2	5.9	6	2.3	2.6

*First number is attributed to the leather and the second is the mark attributed to the felt.

All the five leather samples have similar thickness, with an average around 1 mm, measured with a calibrated micrometer.

The best results for tensile strength and percentage extension were obtained for sample B, black goat leather. Sample A (dark brown napa leather) and B had the highest values for single edge tear load.

All the five samples showed very good properties of color fastness in dry and wet conditions.None of the samples had any problems at more than 150000 flexions, suggesting a very good flex resistance.

The softest leathers showed to be sample B and C (vegetal tanned leather), while the stiffest was D (leather with applied surface). After the initial measurements, samples were exposed to the following conditions for 24 hours (Table 2).

Table 2. Experimental conditions for the five samples.

Experiment/Conditions	Temperature, °C	Humidity, %
E1	50	-
E2	-	70
E3	-10	-

The graphs below show (Figure 2) the results of the physical-mechanical tests for the five leathers before and after exposing them to special conditions specified in experiments E1, E2 and E3.

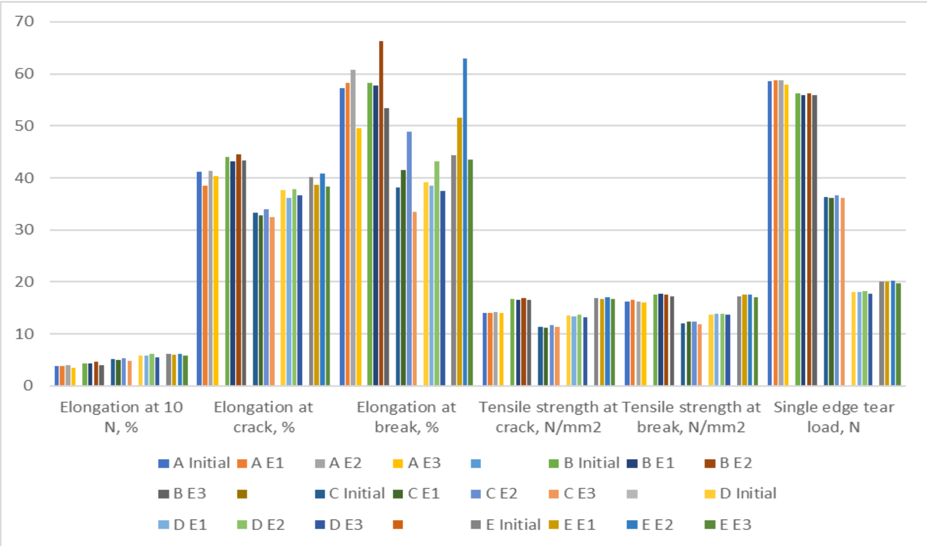

Fig. 2. Tests results for leather samples after being exposed to special conditions.

The information provided by Figure 2 leads to the conclusion that the variation of atmospheric conditions influences the values of sample mechanical properties. The explanation can be that temperature increased value (50°C) remove the water content from samples, reducing the value for all the mechanical properties, while temperature low value (-10°C) increase the rigidity of the sample leading to smaller values. Also, high humidity (70%) helps water retain in the sample structure, providing fiber soften and determine the increase values for the mechanical characteristics.

Colorimetric measurements were made before and after 24 hours of UV irradiation using a UV lamp, type VL 6LC with irradiation at 365 nm (Table 3).

Table 3. CieLab parameters for the five samples, before irradiation.

	Parameters				
Sample	L*	a*	b*	C	h
A	23.95	2.01	-4.68	5.09	293.1
B	18.97	0.22	-5.45	5.46	272.1
C	53.31	10.28	15.08	18.25	55.71
D	55.71	0.30	-0.74	0.81	292.2
E	27.04	3.61	-0.94	3.73	345.4

The obtained results (Table 4) show that none of the five samples underwent significant changes after 24 hours of UV irradiation.

Table 4. CieLab parameters for the five samples, after 24h UV irradiation.

	Parameters				
Sample	L*	a*	b*	C	h
A	23.99	2.03	-4.69	5.02	293.3
B	19.01	0.24	-5.41	5.48	272.2
C	53.37	10.32	15.07	18.22	55.74
D	55.78	0.32	-0.77	0.83	292.3
E	27.01	3.57	-0.95	3.75	345.5

4. CONCLUSIONS

The objective of this study was to evaluate the behavior of five different leathers that can be used as covers for steering wheel by subjecting them to special conditions and determining their physical-mechanical properties. All the tests were performed according to actual standards in ICPI accredited laboratory. The types of leathers were chosen based on the usual preferences of customers and they were subjected to various experiments to simulate those that may appear under normal conditions of use.

The results of the experiment showed that all five samples have good physical-chemical properties, which vary depending on the type of leather and are influenced by climatic conditions.

Overall, the study provides valuable insights into the characteristics of different types of leather and can help future research involved in developing more durable and long-lasting steering wheel cover leathers.

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