

**STUDY OF PHYSICAL-MECHANICAL PROPERTIES OF LEATHER USED FOR
TRANSFORMATION ASSORTMENT**

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Abstract: *In this research, the leather used for the transformation assortment was selected and the physical and mechanical properties of the selected finished leather were studied. Tensile strength of calf, cow, sheep and goat leather obtained from "GOLD LEATHER EXPORT IMPORT" and "YUKSALISH CHARM SANOAT" LLC enterprises, elongation at 10 MPa tension, reversible and irreversible deformation of leather, elasticity, water permeability indicators were determined and analyzed. Based on standards (GOST 939-2021, GOST 938.21-71, GOST 939-2021, GOST 938.11-69, GOST 28554, GOST 28882), it was researched in the research laboratory of the institute. The results obtained from the physical properties of the finished products (leather for the upper part of the transformation bag), thickness, tensile strength, elongation at 10 MPa, reversible and irreversible deformation of leather, uniformity, water permeability were expressed in tables and histograms. The results of the experiments obtained in the tables and histograms of the experiment show that the breaking strength of the sample is calf leather, its index is equal to 1025 N, and it is known that it is 2.1 times more rigid than sheep and goat leather. cowhide by 87%, calfskin by 89%, sheepskin by 86% and goatskin by 80%, irreversible deformation cowhide by 13%, calfskin by 11%, sheepskin by 14% and goat leather changed up to 20%, calf and goat leather were found to have higher purity. From the results of the experiment, the physical and mechanical properties of calf leather for bags were determined: resistance to external influences, durability, deformation, hardness, heat and cold resistance. It was found that the strength, air permeability, naturalness and all other characteristics of the calf skin meet the requirements of the transformation bag, and its physical-mechanical and hygienic indicators met the consumer's demand in all parameters and were recommended for the new transformation assortment.*

Keywords: *strength, elongation at break, uniformity, air permeability, deformation, water application*

INTRODUCTION

Leather goods satisfy a certain need of the consumer and are part of the clothing ensemble. Therefore, depending on the purpose of the leather products, many requirements are set, among which functional, thoroughness, aesthetic and technical-economical requirements occupy the main place. Functionality of leather is provided by indicators of their anthropometric characteristics (size, fullness, shape, etc.), mass, flexibility, protection from heat and moisture (Abbasova & Ochilov, 2005): maturity, physical and spiritual it is characterized by its shelf life, shape retention, appearance during use, susceptibility to repair, aesthetics - style direction, integrity of its composition, style and originality of the model; feasibility is determined by production and repair costs. Today, in the production of bags and leather accessories, not only consumer demand or fashion direction, but also the choice of leather suitable for where and for what purpose the manufactured product will be used, for which season (Khojiyev & Turdieva, 2020), at the same time special importance should be given to the creation of a model corresponding to its characteristics (Temirova & Kadirov, 2005). Depending on the type of leather raw material, the method of cooking, the character and composition of the finishing are different. All processes of treatment of calf, cow, sheep and goat skins for experimental options were carried out according to the method of "GOLD LEATHER EXPORT IMPORT" and "YUKSALISH CHARM SANOAT" LLC enterprises, the chemical composition, physical and mechanical properties of the finished product were determined.

The indicators describing the physical and mechanical properties of leather include strength and elongation at break, elongation under the influence of tension less than breaking strength, resistance to one-time and repeated stretching, singleness, resistance to decay, resistance to hot-humid conditions, (Khojiyev & Turdieva, 2022).

MATERIALS AND METHODS

Leather obtained from different types of animal skins must meet the requirements of State Standards. Determination of the physical and mechanical properties of the finished leather obtained for the experimental test was carried out according to a known methodology (Golovteeva & Kutsidi, 1987). Determination of the chemical properties of the finished product (leather for the upper part of the transformation bag) was carried out on the basis of the regulatory documents listed in table 1.

Table 1. Standards used to determine the physical properties of the finished product

Indicator	Regulatory documents
Water wetting	GOST 938.22-71
Water permeability	GOST 938.21-71
Thickness	GOST 939-2021

Tensile strength	GOST 938.11-69
Elongation in elongation L (%)	GOST 28554
Deformation ε_n (%)	GOST 28882

Experimental studies were conducted on modern equipment installed in the test laboratory of the Namangan Institute of Engineering Technology.

The thickness of the leather also depends on the chemical substances in its composition. The more chemical substances are applied to the skin, the more the skin swells, the thicker the leather becomes.

FINDINGS AND DISCUSSION

The thickness of the leather was determined based on the GOST 939-2021 standard. The thickness of leather is about 0.6-2.3 mm. The thickness of the leathers taken for the experiment was measured with a special equipment YG141D - thickness gauge, and the thickness of the samples was determined, the thickness of the leather samples is shown in Table 2.

Table 2. Leather thickness

Leather type	Leather thickness (mm)
Cow leather	1,0
Calf leather	1,0
Sheepskin	1,0
Goat leather	0,9

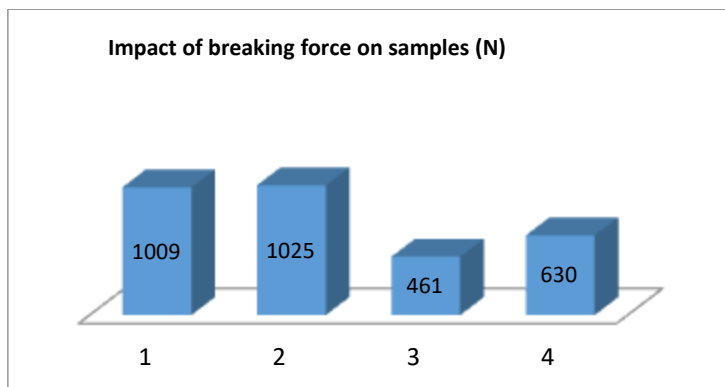
The physical properties of the finished product (leather for the upper part of the transformation bag) were determined according to GOST 938.11-69.

Tensile strength is especially important in the manufacture of leather goods, as the goods are exposed to significant mechanical influences. Mechanical properties include tensile strength, elongation at break, work done at break, relative tensile strength, etc. (Fukin & Kalita, 1988). These features are used to show the maximum mechanical ability and quality of the leather. In order to determine them, a rectangular sample was prepared from the gasses on the cutting device DW1111, 50 mm wide and 250 mm long, i.e. 50x250 mm. The tests were conducted on a YG026T cutting machine. The distance between the clamps of the machine was equal to 150 mm for experimental samples. A high index of breaking strength indicates the strength of the leather, Table 3 shows the results of the experiments.

Table 3. Elongation indicators of the material at break

Sample	Indicators				
	Force (N)	Elongation (mm)	Elongation (%)	Work (J)	Downtime (s)
Cow leather	1009	38,4	19,20	17,3	15,5
Calf leather	1025	52,4	26,20	18,5	20,9
Sheepskin	461	42,3	21,65	21,7	21,4
Goat leather	630	51,9	25,95	7,47	12,5

Tensile strength is defined as the force required to break a specimen when it is stretched at a given size and speed. Breaking force is expressed in newtons. The tensile strength and elongation at break of leather were determined. It was found that the higher the force of the leather, the stronger it is (Figure 1).

*Figure 1. Effects of tensile strength on samples.*

The analysis of the breaking force shows that the hardest sample is option II, its indicator is equal to 1025 N, and it is known that it is 2.1 times higher than options III and IV. Elongation at break due to the force applied to the samples was higher in option I than in options III and IV, but the elongation at break was not high, it was found to be higher in options II and IV, It can be seen that option II of the sample elongation at break is high, calf leather is stronger than cow, sheep and goat leather (Figure 2).

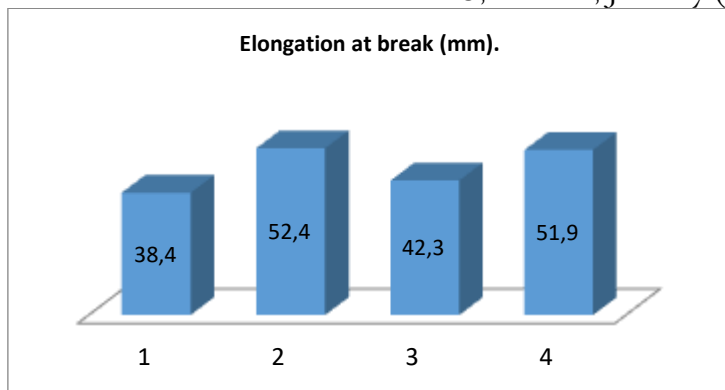


Figure 2. Elongation of samples at break (mm)

Elongation at break due to the force applied to the samples was 38.4 mm in option I, even though it was subjected to a higher force than options III and IV, the elongation at break was not higher. Elongation in options II and IV was 52.4 mm and 51.9 mm, it can be seen that the elongation at break of the II option sample is higher, and it was determined that calf leather is stronger than cow, sheep and goat leather (2 - picture). Deformation is also one of the most important characteristics of leather. Each material has its own stress and deformation. Deformation of leather is understood as its stretching under the influence of applied force and its return to its original state when the applied force is removed. The deformation consisted of the following parts: the belt part returned at a high speed after the loads were removed from the test specimens; elastic deformation was detected at a small speed; plastic deformation did not return after removal of loads from the samples, that is, residual deformation was formed. To determine the reversible and irreversible deformation of leather, experimental samples of 150x60 mm were cut from each cow, calf, sheep and goat skin. Reversible and irreversible deformation of leather was determined using the following formula.

Deformation elongation is expressed by two indicators:

1. Absolute elongation, measured in mm:

$$l_m = L_1 - L_0 \quad \text{mm}$$

a) $l_{m1} = L_1 - L_0 = 17,3 - 15 = 2,3 \text{ mm}$ extension, return $L_1 - L_0 = 17 - 15 = 2 \text{ mm}$.

b) $l_{m2} = L_1 - L_0 = 17,8 - 15 = 2,8 \text{ mm}$ extension, return $L_1 - L_0 = 17,5 - 15 = 2,5 \text{ mm}$.

c) $l_{m3} = L_1 - L_0 = 18,5 - 15 = 3,5 \text{ mm}$ extension, return $L_1 - L_0 = 18 - 15 = 3 \text{ mm}$.

d) $l_{m4} = L_1 - L_0 = 20 - 15 = 5 \text{ mm}$ extension, return $L_1 - L_0 = 19 - 15 = 4 \text{ mm}$.

2. Relative elongation, measured in percent::

$$\varepsilon_n = \frac{l}{L} \cdot 100 = \frac{(L_1 - L_0)}{L_0} \cdot 100\%$$

Here: L_0 is the initial length of the leather, mm; L_1 is the length of the leather after stretching.

$$\text{a) } \varepsilon_{n1} = \frac{l}{L} \cdot 100 = \frac{(L_1 - L_0)}{L_0} \cdot 100\% = \left(\frac{2}{2,3}\right) \cdot 100\% = 87\% \quad \text{return, irreversible}$$

$$100\% - 87\% = 13\%.$$

$$\text{b) } \varepsilon_{n2} = \frac{l}{L} \cdot 100 = \frac{(L_1 - L_0)}{L_0} \cdot 100\% = \left(\frac{2,5}{2,8}\right) \cdot 100\% = 89\% \quad \text{return, irreversible}$$

$$100\% - 89\% = 11\%.$$

$$\text{c) } \varepsilon_{n3} = \frac{l}{L} \cdot 100 = \frac{(L_1 - L_0)}{L_0} \cdot 100\% = \left(\frac{3}{3,5}\right) \cdot 100\% = 86\% \quad \text{return, irreversible}$$

$$100\% - 86\% = 14\%.$$

$$\text{d) } \varepsilon_{n4} = \frac{l}{L} \cdot 100 = \frac{(L_1 - L_0)}{L_0} \cdot 100\% = \left(\frac{4}{5}\right) \cdot 100\% = 80\% \quad \text{return, irreversible}$$

$$100\% - 80\% = 20\%.$$

The reversible and irreversible deformation indicators of the test samples determined using the formulas below are presented in Table 4 (Koblyakova, 1986).

Table 4. Indicators of reversible and irreversible deformation of leather samples

Indicators	Co	Calf	Sheep	Goat
	w leather	leather	skin	leather
	1-Sample	2-Sample	3-Sample	4-Sample
Irreversible deformation (%)	13	11	14	20
Rebound deformation (%)	87	89	86	80

The reversible deformation of the leather samples obtained from the different animal skins tested was 87% for cow leather, 89% for calf leather, 86% for sheep leather and 80% for goat leather, and the irreversible deformation was 13% for cow leather and calf leather. leather changed by 11%, sheepskin by 14% and goatskin by 20% (Figure 3,4). Such indicators of the percentage of reversible deformation show that the calf leather samples quickly return to their initial state after stretching.

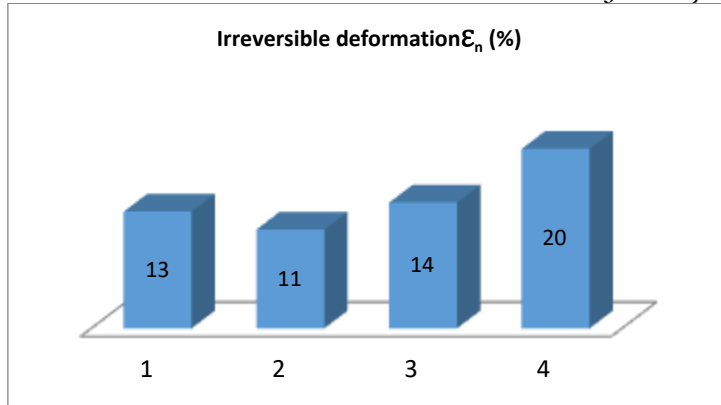


Figure 3. Irreversible deformation change of leather

It can be seen that sample IV goat leather had the highest rate of irreversible part of 20%, and sample II calf leather had the lowest rate of 11%. If leathers have fewer parts that return when stretched, the product made from them will wrinkle less and be durable for a long time.

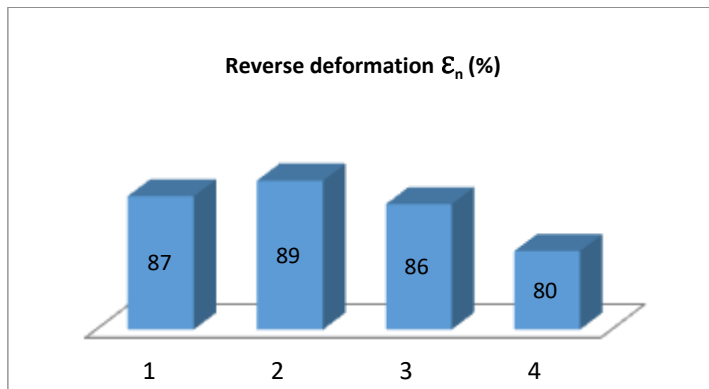


Figure 4. Rebound deformation (%) change of leather

It can be seen from the results of the study that the recovery deformation rate of sample II calf leather was the highest 89%, and this indicator of recovery deformation percentage showed that the calf skin quickly returned to its initial state after stretching. Another indicator of the durability of leather is its hardness. The uniqueness of the leather was determined in a special YT-TDY500 device (Kukin & Solovyev, 1974). To determine the uniformity, a sample was prepared according to the size specified in GB2679*3 (sample length 70mm, width 38mm), each sample was tested three times and the average was taken.

Calculation formula:

$$S = n \cdot R(mN * m)$$

In the formula: n is the division value corresponding to the number of twists;

R is the actual number of factors from 0 to 100.

$$S_1 = n \cdot R(mN * m) = 0,20 \cdot 16,5 = 3,3mN * m$$

$$S_2 = n \cdot R(mN * m) = 0,20 \cdot 21,5 = 4,3mN * m$$

$$S_3 = n \cdot R(mN * m) = 0,20 \cdot 21 = 4,2mN * m$$

$$S_4 = n \cdot R(mN * m) = 0,20 \cdot 21,9 = 4,38mN * m$$

Using the following formula, the uniformity indicators of the test samples were determined (Table 5).

Table 5. Uniformity indicators of experimental samples

Indicator	Cow leather	Calf leather	Sheeps kin	Goat leather
	1-Sample	2-Sample	3-Sample	4-Sample
Singularit				
y	3,3	4,3	4,2	4,38
(mN*m)				

The lowest level of uniformity was found in sample I of 3.3mN*m, and the highest level of uniformity was found in samples II and IV of 4.3 and 4.383mN*m (Fig. 5).

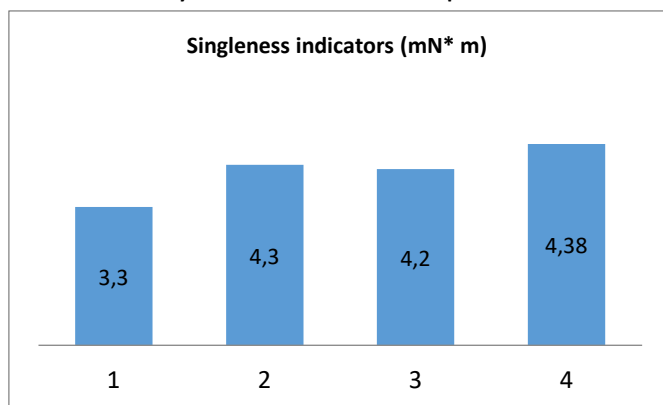


Figure 5. Unity of experience samples

Among such indicators of hardness, it was found that samples II, IV, calf and goat leather have high hardness, and they can maintain their condition for a long time under the influence of a certain force.

The skin has the ability to absorb various substances in liquid, gas or vapor state. In this case, the mass, dimensions, strength, uniqueness and other properties of the leather will change. Based on the GOST 938.21-71, GOST 938.22-71 standards, it was determined to what extent the skin is wetted by water and water permeability when the surface is wet (Figure. 6).

Table 6. Water permeability indicators of the samples

No	Test samples	Water permeability mm/sm ² soat	Soaking in water, soaking in 2.5 ml of water, per minute
1.	I- Sample	0,18	45
2.	II- Sample	0,21	45

3.	III-Sample	0,25	45
4.	IV-Sample	0,36	36

In the results of the research, the water permeability of sample I was 0.18 mm/cm²h, sample II was 0.21 mm/cm²h, sample III was 0.25 mm/cm²h, and sample IV was 0.36 mm/cm²h. cow and calf skins have low water permeability, and cow and calf skins are resistant to rain and water.

CONCLUSION AND RECOMMENDATIONS

From the above analysis, we concluded the following. The chemical composition, physical and mechanical properties of calf, cow, sheep and goat leather obtained from "GOLD LEATHER EXPORT IMPORT" and "YUKSALISH CHARM SANOAT" LLC enterprises were determined and analyzed. It should be noted that leathers made from all animal species differ in the way they are cooked, the nature of the finishing, and the composition, depending on the type of raw material. Also, the properties of different leathers for the transformation range were researched and useful leathers were identified for the bag. The experimental results obtained in the given tables show that the physico-mechanical properties of calf leather for bags: resistance to external influences, durability, deformation, stiffness, heat and cold resistance were determined, and calf leather was recommended for transformation sum. It was determined that the strength, air permeability, naturalness and other properties of calf skin meet the requirements of our transformation bag, and its physical-mechanical and hygienic indicators fully meet the consumer's requirements in all parameters.

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REFERENCES:

- 1.Abbasova, N.G., Akhmedov, B.B., Makhkamov, SH.G., Ochilov, T.A. Light industrial materials science. Tashkent.-2005. -P. 45-65.
- 2.Turdieva, O & Khojiyev, A.A. *ACADEMUCIA An International Multidisciplinary Research Journal*. DOI 10.5958/2249-7137.2020.01801.7 India. 2020. Vol. 10, Issue 12, 2020. Pages: 767-772.
- 3.Turdiyeva O. &, Khojiyev A.A. Development of multi-functional innovative bag for children. International Scientific and Practical Internet Conference of Young Students and Students. *Resource-saving technologies of light, textile and culinary industry*. November 18-19, 2022, Pages: 32-34.

4. Turdieva O. & Khojhiyev A.A. *European Scholar Journal. Investigation of properties of materials used for multifunctional bags*. ISSN:2260-5562. Spain. 2021. Vol. 2, No. 3, 2020. Pages: 121-126. The Economist. (2004). The Rise of the Green Building, Accessed on 10 Dec 2017, available online at: http://economist.com/PrinterFriendly.cfm?Story_ID=3422965

5. Temirova M. & Kadirov T.J, Leather fur technology. Study guide. T. 2005. -P. 31-45.

6. Fukin V. A. & Kalita A. N. Technology is a trailblazer. Uchebnik dlya vuzov. V 2 ch. Ch. 1. – M.: Legprombytizdat, 1988. – 272 p.: il.- Bibliogr.: -P.268.

7. Golovteeva A. & Sankin L.B. laboratory workshop on chemistry and technology of leather and fur.- M.: Legprombytizdat, 1987. -P. 312.

8. Koblyakova A.N. Laboratory workshop on textile materials science. M, "Legprombitizdat", 1986. -P.166-172.

9. Kukin G. & Solovyev A.N. Laboratory workshop on textile materials science. M., "Legkaya industriya", 1974.-P.21-33.