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STUDY ON THE MECHANICAL PROPERTIES OF LEATHERS REINFORCED WITH SUPPORTING MATERIALS

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Abstract: *Depending on the design chosen for the production of leather goods, leather can be used alone or together with various supporting materials which give form and strength to it. Reinforcements are extremely important component of leather goods whether wallet or purse, handbags or suitcases, belts or portfolio. Reinforcements which provide support to the leather are used to change the drape and handling of leather goods. The physico-mechanical properties of the leather goods may vary depending on the supporting material used. In this study, the mechanical properties of leather for handicrafts reinforced with supporting materials, in particular, salpa and syntex with different thicknesses were examined. For this purpose, the measurement of thickness, tear load, tensile strength and percentage extension have been performed. The highest tensile strength and tear load results were obtained for the leather used with syntex 1 and syntex 2 as 23.5 N/mm^2 and 397.5 N, respectively. In spite of high values of the percentage extension of syntex 1 and syntex 2, these values were decreased when they were used with leather. It was also determined that the tensile strength and tear load values of the leather adhered with salpa are increased with the increased thickness of salpa materials.*

Key words: *Leather, Leather handicrafts, Reinforcement materials, Salpa, Syntex*

1. INTRODUCTION

Leather plays an important role among handicrafts and industrially manufactured products. All kinds of bags, luggage and other travel items with different functions, sizes, structures and different materials used together, and small items such as belts, desk pads, wallets, key rings, accessories etc. in other words articles made of leather are considered as leather goods [1]. The physical properties of leather constitute the important quality parameters that determine the performance characteristics in their areas of application [2]. In leather goods production, the leathers that do not have all the desired properties and do not give the desired form alone are reinforced with different supporting materials. Many of the designs would not be possible and most of the modern leather goods would be soft and shapeless without reinforcements [3]. The choice of supporting materials varies according to the product, its model, visual and physical harmony of the product design and the technical features (durability, etc.) it will bring to the applied area. If the leather you choose has too much drape or is too pliable, then you can consider laminating reinforcement to the back of the leather to change its hand.

A good reinforcement to consider is salpa which is a bonded leather fiber material [4]. Salpa or bonded leather is made from leather shavings and leather pieces obtained as waste in the leather industry. It is produced in layers by milling of vegetable leather scraps as well as chrome shavings, mixed with fat and a binding agent (latex) [5]. Salpa gives to the leather features such as appearance, touch and stiffness. Another option is syntex (or microbase) which is a microfiber reinforcement material which is lightweight, durable and flexible [6]. Both of these materials (salpa and syntex) sold in different thicknesses ranging from 0.5 mm to 2.0 mm.

Leathercraft and leather goods production constitute an important branch of the leather industry. Leather exhibits different physical behaviors depending on the differences in production and the chemicals used. Unlike most textile materials, leather has irregular fiber structure [7] which makes leather goods differ in terms of mechanical properties [8]. Even the natural fibrous structure of leather gives its unique physical properties of handle and ability to accommodate to the stresses and forces subjected during its use [9], the physico-mechanical properties of the leather goods may vary depending on the supporting materials used, since these materials also have different mechanical properties. There is a dearth of information on the mechanical properties of the reinforcements used with leather. Therefore, this study was performed to understand and select proper material for a particular application and to learn which combination has better performance and durability.

2. MATERIALS AND METHODS

2.1 Materials

In the study, calf leathers (Sepiciler, Turkey) processed for leathercraft were used. Syntex (SF Trade Leather, Turkey) with two different thicknesses (syntex-1 and syntex-2) and salpa (SF Trade Leather, Turkey) with three different thicknesses (salpa-1, salpa-2 and salpa-3) were used as supporting materials in the production of leathercraft samples.

2.2 Methods

Sampling and conditioning

After measuring the thicknesses of leather, salpa and syntex samples, the leather and the supporting materials were bonded with the same type of adhesive. All the specimens have been prepared in a certain amount for the physical tests to be applied in three parallel. The test samples for the physical tests were taken from the sampling locations as specified in ISO 2418, and conditioning has been performed according to ISO 2419 at 23 ± 2°C temperature and 50 ± 5% relative humidity [10,11].

Measurement of physico-mechanical properties

The thickness of the test samples was measured using a Satra (UK) thickness measuring device in accordance with the ISO 2589 standard [12]. Physical properties of leather and supporting materials were tested according to ISO 3376 using Shimadzu AG-IS (Japan) device [13]. The leather and supporting materials for the tear load test were prepared by cutting the samples in the dimensions specified in the standard using the steel template cutting blades according to ISO 3377-1 [14].

3. RESULTS AND DISCUSSION

The mechanical properties of leather are expected to be sufficient to the stresses applied onto the leather in the process of creation as well as physical changes in the material which result from the application of force on product during the usage [15]. For this reason, strength properties are very important in terms of technological and the production knowledge. High tensile strength is one of the most desired features in finished leathers and leather goods. In addition, it is very important that the elongation is at a sufficient level in terms of the fact that there should not be any deformation on the grain and the fibers should not deform irreversibly in the case of pulling the leather into the mold or flexing and bending. Since leather belongs neither to the category of 'textiles', nor to the category of more rigid materials, such as cardboard, plastic or acrylic, and it is at the same time soft and flexible, as well as sturdy and strong [16], its incorporation or combination with flexible or foldable displays or support structures should be investigated to reveal the appropriate structures which would provide the properties that are required from different leather goods. Tensile strength and percentage extension test results of leather, supporting materials and the leather reinforced with these materials obtained in this study are given in Tables 1 and 2.

Table 1. *Tensile strength and extension values of the investigated materials*

Materials	**Tensile Strength, N/mm^2**	**Extension, %**
Leather	22.7±0.7	58.6
Syntex-1	14.7±1.1	93.5
Syntex-2	18.3±1.7	103.8
Salpa-1	17.1±1.2	39.6
Salpa-2	6.9±1.4	120.9
Salpa-3	11.5±2.2	35.7

Table 2. *Change in the tensile strength and extension of the leather used with supporting material*

Materials + leather	**Tensile Strength, N/mm^2**	**Extension, %**
Syntex-1 + leather	23.5±2.3	49.5
Syntex-2 + leather	17.5±0.7	53.4
Salpa-1 + leather	15.6±3.8	63.6
Salpa-2 + leather	16.5±1,5	61.5
Salpa-3 + leather	16.7±2.1	69.7

When the results of the study were examined, it has been observed that the physical tests of leather and supporting materials used give different results depending on whether they are used alone or together (Table 1-4). Calf leather has the tensile strength and percentage extension values as 22.7 N/mm^2 and 58.6%, respectively. Syntex-1 has the tensile strength of 14.7 N/mm^2 and 93.5% of extension, but when leather is used with syntex-1 the tensile strength increases (23.5 N/mm^2), while the percentage extension value decreases (49.5%). Thus, while the tensile strength of the product increases, the problems caused by extension will decrease.

The tensile strength of syntex-2 is 18.3 N/mm^2, but when it was adhered to leather the tensile strength has been determined as 17.5 N/mm^2. It has been found that the tensile strength is slightly lower when syntax-2 used with leather. Percentage extension of syntex-2 is 103.8%, this value decreases to 53.4% when it used with leather. The reason for the low strength is thought to be due to the thickness of syntex-2 being thicker than syntex-1.

Salpa-1 alone has the tensile strength of 17.1 N/mm^2 and the extension of 39.6%. When it was bonded to leather, it has 15.5 N/mm^2 and the extension of 63.6%. It has been observed that when salpa-1 is attached to leather, the tensile strength decreases and the extension increases. While the tensile strength of salpa-2 was 6.9 N/mm^2 and the extension was 120.9%, when leather and salpa-2 were adhered the tensile strength was determined as 16.5 N/mm^2 and the extension was determined as 61.5%. Vice versa situation has been observed in comparison with salpa-1 + leather as the tensile strength of leather + salpa-2 was increased and the extension was decreased.

When tested alone salpa-3 had tensile strength as 11.5 N/mm^2 and the extension as 35.7%, when leather and salpa-3 were used together, the tensile strength was found as 16.7 N/mm^2, the extension was determined as 69.7%. It was determined that the tensile strength values are increased with the increase of salpa thickness. The same could not be said regarding the extension values. However, the mean value of the tensile strength of the leather used with the salpa materials with different thicknesses is around 16.3 N/mm^2 and the mean extension is 64.9%.

UNIDO has advised tensile strength min 20 N/mm^2 for acceptable quality of calf leathers [17]. It is stated that the tensile strength value should be at least 22.5 N/mm^2 and 25 N/mm^2 in vegetable and chrome tanned leathers for bags, luggage and saddlery [18]. These leathers with thickness over 1.25 mm should have the tensile strength value 15 N/mm^2 at least [19]. When the tensile strength values of the leather and reinforced leathers are evaluated, it was seen that the obtained values are in the range of the acceptable limits.

In a study, hybrid leather (laminated Permair leather, thickness 1.7 mm) obtained by hot plate pressing of a separately moulded microporous polymer film to split leather surface using adhesive layer had tensile strength value as 21.9 N/mm^2. The lamination of split leather by the microporous polyurethane film improved tensile property of the hybrid leather [20]. It was also reported that when sheep nappa leather was fused with the interlining having nylon, the tensile strength and tear load of this leather were increased [21].

When the leather is under the effect of a force, it first shows elongation, and then it comes to the rupture stage and the elongation increases at this stage. In addition, while less elongation causes the leather to tear easily, excessive elongation can cause deformation of the leather. The elongation value of the vegetable tanned leather for bags, suitcases and sandals should be max 50% [19]. In other reference, the percentage elongation of the vegetable and chrome tanned leather for saddlery and bags in thickness of 2 - 4 mm should be 50% and 75% maximum [18]. If the elongation value is higher than the desired values, it may cause deformations and deformities. It is seen that the elongation or extension values in this study are within the maximum values specified in the mentioned studies.

Table 3. *Tear load and thickness values of leather and supporting materials*

Material	**Tear load, N**	**Thickness, mm**
Leather	271.1±0.3	1.9±0.05
Syntex-1	54.5±0.7	0.4±0.01
Syntex-2	162.2±0.3	1.1±0.01
Salpa-1	8.4±0.2	0.4±0.01
Salpa-2	44.9±0.5	0.7±0.01
Salpa-3	21.2±0.4	0.9±0.02

Table 4. *Tear load and thickness values of the leather reinforced with supporting materials*

Materials + leather	**Tear load, N**	**Thickness, mm**
Syntex-1 + leather	299.0±1.5	2.3±0.02
Syntex-2 + leather	397.5±1.2	2.9±0.07
Salpa-1 + leather	239.3±0.6	2.4±0.05
Salpa-2 + leather	253.5±0.7	2.7±0.02
Salpa-3 + leather	257.6±0.3	2.8±0.01

When the tear load of the leather (thickness 1.9 mm) was found as 271.1 N and the tear load of syntex-1 (thickness 0.4 mm) as 54.5 N, the tear load value for the bonded leather and syntex-1 (thickness 2.3 mm) was determined as 299.0 N. It means that when the leather will be reinforced with syntex-1, the tear load of the product will increase. While the tear load of syntex-2 (thickness 1.1 mm) was 162.2 N, the tear load of the syntex-2 adhered to leather (thickness 2.9 mm) was found to be 397.5 N. Thus, when leather and syntex-2 are adhered, the tear load of the obtained product will also increase. The tear load values of salpa-1, salpa-2 and salpa-3 were determined as 8.4 N, 44.9 N and 21.2 N, respectively. The tear load values for the leather reinforced with these materials were found to be 239.3 N, 253.5 N and 257.6 N, respectively (Table 3, 4). It was observed that the tear load values are increased with the increased thickness values of the leather adhered with salpa materials (2.4 mm, 2.7 mm and 2.8 mm).

Tear load is one of the strength properties sought in order to know the resistance of the finished leathers against tearing under any force effect during their use. The tear strength of the leather can vary with the natural structure of the leather, the processes applied and the type of tanning [22]. It was stated that the tear strength depends on the thickness and type of the leather [23]. It has been reported that tear load of shoe upper leather should be of 30 N [17]. It is seen that the tear load values determined in this study are higher than the acceptable values. For this reason, it can be interpreted that the risk of tearing of the reinforced leather is low in the face of the stress and tensile effects that may arise during both the manufacture of leather goods and during use.

4. CONCLUSIONS

Supporting materials are all materials that facilitate the durability, appearance and production of the goods. The quality of the material used in the production of leather goods affects the price as well as the durability of the product and its market position. Depending on the thickness variation of the supporting materials used, it was determined that the tensile strength, percentage extension and tear load properties of the samples differ when the leather and the supporting material were used together. The best physico-mechanical properties results were obtained for the leather used with syntex 1 and syntex 2 materials in terms of the tensile strength and tear load as 23.5 N/mm^2 and 397.5 N, respectively. In spite of high values of the percentage extension for syntex 1 and syntex 2, these values were decreased when they were used with leather and the best percentage extension result was found for the leather used with syntex 1 as 45.5%. It was also determined that the tensile strength and tear load values are increased with the increased thicknesses of the leather adhered with salpa materials.

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