

Performance of Leather Uppers of Local Footwear products and the Determinants

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ABSTRACT

Various literatures acknowledged that Ethiopian sheep and goats skins are appreciated by the international leather industry because of their high strength at lower thickness and flexibility. On the country the local leather upper footwear products have low market position both at national and international levels. This research has, then, risen to investigate the performance of the upper leather of local footwear products against the standard requirements. Samples of local footwear, black upper leathers and finished leathers for shoe consumption, and semi-processed suede upper leather have been prepared and tested according to the South Africa National accreditation Standards (sanas) test method in the Leather Industry Development Institute, Addis Ababa, Ethiopia. Both physical and mechanical Laboratory test results have been collected and then manipulated using the descriptive analysis. The research result illustrated that the average tear strength, tensile strength and percentage of elongation of the upper leather sample is below the minimum requirement of the standards set by the various test methods. The water resistance and colour fastness to rubbing are other acute of the local footwear uppers. But they have shown good achievement in vamp and bally flexing property. These major pitfalls recall to the quality of the finished leather supplied by the local tannery plants for footwear consumption. Hence, local tannery plants should determine the quality requirements their products and the gaps through investigating their production process and taking regular mechanical and physical laboratory tests. Policy makers have to check their leather and leather products working directives to introduce obligatory condition to improve the manufacturing process of the local tannery plants and monitor whether they are producing according to the requirement when measure against standards.

Keywords : Component; Leather upper; Local footwear; Quality determinants; Mechanical Performance, Physical Performance

1 INTRODUCTION

The leather industry is one of the oldest and largest industries that occupy a place of prominence in the global economy in view of its massive potential for employment, growth and exports. The world demand for the leather and leather products was USD 24.3 billion in the 2001 [1] and it stood at USD 68.57 billion in 2003 [2] which then has skyrocketed to USD 347.50 billion in 2010 [3] due to the consumption in large volumes by the developed countries like the USA, Europe, Australia and Japan [2].

Footwear market is the biggest market amongst all the leather sub-sectors, accounting for more than 70 percent of the global leather consumption [3] and 58.5 percent of the global footwear types [4], [5]. Worldwide footwear consumption has rapidly increasing from year to year: 11 billion pairs in 1999 [5] to more than 20 billion pairs of shoes in 2005 [6]. The worldwide per capita consumption of footwear has considerably increased from year to year: for instance, from 1 pair of shoes per year for every person in the world in 1950 to almost 2.6 pairs of shoes in 2005 [6]. But this varies from one country to other based on the capital income of the individuals. The exports of footwear products also vary from one to another country not based on the supply of the pelts and other resource but based on the advancement in leather technology. 83 percent of the global footwear products are manufactured in Asian countries [4], where china shares 70 percent [3].

Ethiopia is possessing 90-million livestock pelt population [7] with 48, 27 and 25 Percent is cattle, sheep and goat [8], respectively. With these, the country is considered as first in Africa and the 10th in the world. However, the country's share to the global leather and leather products market is insignificant since its inception: 0.00023 percent in 2001 [1] to 0.000597 percent in 2010 with annual increment of 0.16 percent [3], [9] with that 80 percent of the leather and leather products export is gained from crust and finished leathers [10]. Referring the data from Revenue and Customs Authority showed that, in 2010, Ethiopia has exported 577,917 but imported 10,772,957 pairs of shoe. The export has a share of 5 percent with annual increment of -3.96 percent since 2007. This illustrated that the high demand of the shoe in the country is substituted by the imported shoes [11].

However, in addition to the high pelt population, various literatures have appreciated that Ethiopian hair sheep skins and goats originating from the highland are appreciated by the international leather industry because of their high strength at lower thickness and flexibility [12], [13] which makes them very suitable for gloving, garment leather and shoe upper [7]. These skins have fine fiber structure that lends itself to good quality suede. But the quality of the inland leather footwear is a chronic problem that made to experience less reputation and insignificant share local and international

market [12]. Because of this, though there is great growth in footwear demand, Equivalent leather upper imported footwear, branded as CAT, Reebok, Nike, Timberland and others, are dominating the local market in rapid fashion, even at their second stage (locally named torsion shoes), though are at triple purchasing cost when compared with the local footwear. The assessment result, which has been done on the local customers, demonstrated that more than 67% of respondents give less attention to buy local products. Especially, males at their young age are more vulnerable to buy imported products because of their use property and aesthetic values. Hence, this research has risen with the central objective to investigate the performance of the leather upper local of footwear products.

2 MEASURES OF PERFORMANCE REQUIREMENT OF FOOTWEAR PRODUCTS

The quality of the products is defined as its degree of fitness to meet the needs and desires of the customer. The quality of products can be measured in terms of product performance requirements after the product has been delivered to the customer. In the case of leather products, the performance requirement can be measured in terms of the use property and the aesthetic values that the product should possess [14]. In footwear technology, there are various tests that measure the product performance to confirm that whether the product will exhibit the predetermined requirement while put on use [14], [15]. Some of the performance measures include:

2.1 Mechanical Performance Requirement

The Tensile Strength is maximum tensile stress recorded in extending a test piece to breaking point. Tensile strength is good realm to check whether the leather upper has sufficient structural resistance [15], [16]. **The Percentage Elongation** is the tensile strain of the upper leather of the shoe in the test length at breaking stage. The elongation at break shall provide a medium value, so that the leather has enough elasticity to adapt to the user's feet and to the movements derived from the use of footwear [14]. The elongation should not be too excessive to avoid the ease of footwear deformation [14], [15]. **The Tear Strength** is the median force required to propagate a cut in a specified test specimen. The leather upper should possess high flexibility to prevent the appearance of cracks and tears in the ball area of the footwear upper [14], [15]. **The Vamp and Linear Flexes** are used to determine the flexing endurance of leather uppers and their surface finish after repetitive use in the same and opposite flexing cycle. The tendency for cracks to form in the crease caused by walking can be determined [15]. The leather and its finish shall have high flexibility to prevent the appearance of cracks and tears in the ball area of the footwear upper [14], [15]. **The Ball Burst** is used to define the capability of the finished upper leather to withstand for the ball shaped steel material to burst as instantaneously increasing enforcement. The grain layer shall have a high elasticity, which allows it to withstand the elongation stresses to which it is subjected during footwear lasting, especially on the toe area [14], [17].

2.2 Physical Performance Requirement

The Water Vapour Permeability is to assess the upper leather's breathability, mainly in leather coated with very thick films. Persuading this breathability prevents the heat generated and accumulation, and consequently avoids the sweating of the foot. **The Water Resistance** is a much demanded property of the leather upper for footwear consumption so that the dynamic water resistance test is particularly important [14], [18]. The footwear is experiencing good quality if the upper leather is more cohesive than adhesive to water. **The Colour Fastness to Rubbing** is resistance of a material to damage (marring) and transfer or bleeding of the materials surface colour during mild dry or wet abrasion after repetitive rubbing. Leather upper has to possess adequate fastness to rubbing, so that rubbing does not substantially change the leather appearance [14], [19]. For unlined footwear, it is important to provide a good fastness on the grain side to avoid staining on stockings or feet.

3 METHODOLOGY AND MATERIALS

In this study, samples materials from local footwear which are made up of upper hides and upper leather of sheep and goat skins, finished leather of sheep and goat of grade-III and Grade-I with 0.80mm and 1.00 mm thickness, respectively, ready for upper consumption and semi-processed upper materials on their suede form from both sheep and goat has been prepared from local products of various manufacturers. These materials have been sent to Leather Industry Development Institute, Addis Ababa, Ethiopia, for laboratory tests using the sanas test methods. Test result of tensile strength and percentage elongation, tear resistance, vamp and bally flex, grain detention, water resistance and colour fastness has been collected and then manipulated using descriptive analysis.

4 RESULT AND DISCUSSION

Tensile Strength and Percentage Elongation: In this test, finished goat upper (FGU) and finished sheep upper (FSU) that are made ready for upper shoe production consumption have been use for the investigation using the ISO 3376: 2002 test method. Table1 presented the test result of this physical test.

TABLE 1:
 THE MECHANICAL TEST RESULTS FOR TENSILE STRENGTH AND PERCENTAGE ELONGATION

Product Type	Type of Test	Unit	Test Result
FSU Black	Tensile Strength	N/mm ²	13.6
	% Elongation	%	36.8
FGU Black	Tensile Strength	N/mm ²	27.5
	% Elongation	%	41.8

The ISO 3376: 2002 test method demonstrated that the minimum requirement for the tensile strength is greater than 15 N/mm² and percentage of elongation is greater than 40%. Comparing this minimum requirement with the test result announced that the sheep upper black did not achieve the specified minimum performance requirement in both tests,

whereas the finished goat upper black has shown good performance in tensile strength but slight difference in percentage elongation. This low performance in percentage elongation emphasized that the leather has no enough elasticity to adapt to the user's feet and to the movements derived from the use of footwear [14]. Such problem appeared due to the tanning processes particularly the batting, decreasing and fat liquoring stages [18], [19] and on the mechanical applications in leather finishing i.e. stacking operation [14], [20].

Tear Resistance: The sample used for tensile strength has again been used for tearing resistance using the ISO 3377-2: 2002(E) testing method by applying the double edge testing machine. The test result has been presented in table 2. The ISO 3377-2: 2002(E) test method ascertained that the minimum average tear load of leather upper of a typical footwear should be greater than 50 N.

TABLE 2:
THE MECHANICAL TEST RESULTS FOR TEAR RESISTANCE USING THE DOUBLE EDGE TEST

Product Type	Type of Test	Unit	Test Result
FSU Suede Sara	Average Tear Lead	N	28
	Tear Load	N/mm	28.6
FGU Suede Sara	Average Tear Lead	N	30.1
	Tear Load	N/mm	27.8
FSL Black	Average Tear Lead	N	19
	Tear Load	N/mm	19.9
FGL Black	Average Tear Lead	N	44.4
	Tear Load	N/mm	40.7

Comparing this standard requirement with the test result illustrated that none of the uppers achieved the minimum requirement. This demonstrated that the given samples are driven to be easily bitable by sharpened things and the tears can propagate easily with little start. The samples designated as finished sheep upper suede and finished sheep upper black have shown very less performance, 28N and 19N respectively. With this, the leather upper show low flexibility to prevent the appearance of cracks and tears in the ball area of the footwear upper.

Vamp and Linear Flex: The sample used for tearing resistance has again been used for vamp and linear flex using the ISO 5402: 2003 and ISO 22288: 2006 testing method by applying the double edge testing machine called the Flexometer. The test result of this method has been presented in table 3.

TABLE 3
THE MECHANICAL TEST RESULTS FOR BALLY/LINEAR AND VAMP FLEXES USING FLEXOMETER METHOD

Product Type	Type of Test	Test Result
FGU Black	Flex Test (Bally Flex)	crack of finish layer at 250Kcycle
	Flex Test (Vamp Flex)	Cracking extending to the edge of the test piece at 1000Kcycle
FSU Black	Flex Test (Bally Flex)	No Change
	Flex Test (Vamp Flex)	No Effect

The ISO 5402: 2003 test method embarked that the performance requirement for the ball flex/linear flex to be no significant damage at 150 Kcycle at dry stage. The laboratory test

result defined that the crack starts to happen after 250 Kcycle for the finished goat upper but no damage for the sheep skin. Hence according to the minimum requirement both tests have achieved good performance. The ISO 22288: 2003 test method illustrated that the performance requirement for the ball vamp flexes to be no damage for a minimum of 250Kcycles. Comparing the table 3 with the standard requirement assured that both the finished sheep and goat leather upper have shown good performance.

Colour Fastness: The mechanical test for the colour fastness has been taken for the grade-1 of finished goat and sheep leather that are made ready to be used as upper for leather footwear manufacturing. The test method of ISO 1164: 1993 has been carried out. The test result of colour fastness is presented in table 4.

TABLE 4:
THE MECHANICAL TEST RESULTS FOR COLOUR FASTNESS TEST

Product Type	Type of Test	Unit	Test Result
FSU Black	Dry 150 Cycles	Felt Pad	Grade 4/5
		Test Piece	Grade 2
	Wet 50 Cycles	Felt Pad	Grade 3/4
		Test Piece	Grade 2/3
FGU Black	Dry 150 Cycles	Felt Pad	Grade 4
		Test Piece	Grade 4/5
	Wet 50 Cycles	Felt Pad	Grade 3
		Test Piece	Grade 4

The performance requirement for the colour fastness according to ISO 1164: 1993 is W 3 (grey scale) after 150 cycles dry and 50 cycles wet. Comparing the test results with the standard requirement illustrated that inferring the felt pad grade the finished sheep upper has achieved the standard while the finished goat upper is below the standard.

Water Absorption: The same sample as used in the colour fastness has been taken for the water absorption test of the upper leathers. The ISO 5403:2002 testing method has been used to define the water resistance of the upper leather of the footwear. Table 5 demonstrated the test result of the water resistance of finished goat and sheep uppers.

TABLE 5
THE MECHANICAL TEST RESULTS FOR WATER ABSORPTION TEST

Product Type	Type of Test	Unit	Test Result
FSU Black	Volume: Volume	After 2hrs	% 93.4
		After 24hrs	% 100
FGU Black	Volume: Volume	After 2hrs	% 72.1
		After 24hrs	% 75.5

According to the ISO 5403:2002 standards, the performance requirement of water resistance for the leather upper shoe using the volume-volume ration is 30 percent maximum for two hours. Comparing this with the test result presented on table 5 revealed that none of the samples qualify for this requirement. This insures that the local/inland leather uppers have experiencing more additive property to water which altered the fibre structure and major cause for irreparable deformation and drying.

The Ball Burst Test: The leather upper of both goat and

sheep is by far used for the distension and grain strength tests using the ball burst technique with the ISO 3379/2005 test method. The test result of this mechanical test is presented in table 6.

TABLE 6
THE TEST RESULTS FOR DISTENSION & STRENGTH OF GRAIN
BY THE BALL BURST TEST

Product Type	Type of Test	Unit	Test Result
FSU Black	Distension At Crack	mm	10
	Load At Crack	N	280
	Distension at Burst	mm	10
	Load At Burst	N	317.7
FGU Black	Distension At Crack	mm	10
	Load At Crack	N	467
	Distension at Burst	mm	11
	Load At Burst	N	512.7

The ISO 3379/2005 standard revealed that the minimum performance requirement for leather uppers of footwear for detention at the crack is greater than 8mm. Comparing with the test result expressed that all the samples of the grain strength is above the minimum performance of the leather upper.

5 CONCLUSION AND RECOMMENDATION

This research has risen to investigate the performance of the upper leather of local footwear products against the standard requirements. Samples of footwear, upper leathers and finished leathers for shoe consumption have been prepared and tested according the sanas test method. The physical and mechanical laboratory test results showed that the average tear strength, the tensile strength and percentage of elongation of the upper leather sample is below the minimum requirement set by the test methods. The water resistance and colour fastness to rubbing are another acute to achieve the requirements. The good trait that has been experienced by the local shoe products is the bally and vamps flex. These pitfalls greatly affect the use properties of the local footwear. The shortcoming to colour fastness and water resistance affects the appearance of the footwear products.

Hence, local tannery plants should investigate performance their supplied products through conducting regular mechanical and physical laboratory tests. Policy makers have to introduce obligatory requirements to improve the manufacturing process of the local tannery plants and monitor whether they are producing according to the requirement when compared to the standards.

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