Investigating the peeling strength of resin & crepe rubber when attached to leather by means of solvent-based adhesives.

Md. Farhad Ali, Md Tanjid Ahmed Zahid, Tama Rani Sarker* and Tanvir Siddike Moin
Institute of Leather Engineering and Technology,University of Dhakas

ABSTRACT: *The modern technology of footwear and other construction conduct extensive use of adhesives; in exception with sometimes uppers are attached with sole by sewing or in some cases like attachment of heel with nails etc. In this study twenty types of upper, two types of soling materials i.e. resin and crepe rubber and solvent based adhesive are used for assembling forty types of upper- sole combination and corresponding bond strength are determined based on peel test following SATRA adhesive test method. The aim and purpose of this test is to provide a clear guideline for selecting soles, adhesive regarding application methodology, surface preparation for required bond strength in between upper to sole for footwear and other constructions.*

KEYWORDS: *adhesive, bond strength, leather, resin, crepe, SATRA.*

1. INTRODUCTION

Footwear is an item of clothing made by humans that covers and protects the foot, including the soles of the feet. These are made of many different types of materials, such as leather, fabric, and plastic. There are several types of footwear present in modern era i.e. athletic shoes, shoes for work and home, sandals, boots etc. Now-a-days most soles are made of rubber and plastics which are classed as synthetic soling materials. When comparing the use of synthetic soles in the USA and in the UK in 1948, we find that the USA used as high as 83% of non-leather soles in some kind of footwear, whereas in the UK, the percentage was only a quarter of this. The use of cellular soling soon followed and in 1952 the use of these soling boomed in USA namely Cush-N-Crepe and Naron-crepe were familiar. (1) As their basic composition used in manufacture did not differ essentially from normal resin rubber, the term micro cellular resin rubber was widely adopted throughout the world. Up to this time America influenced this soling development most but European suppliers of soling quickly responded by undertaking further development, which had a marked bearing on the growth of rubber and plastic soling. But leather was always the main soling material. In recent years this has been largely superseded by other materials, for example, rubber both vulcanized and microcellular, crepe, synthetic resins and more recently PVC and PU. It has been estimated that sole bond failures account for 30-40% of all returns to manufacturers. In fact, this one fault may involve 1% of total production. Sole bonding, therefore, can be given too much attention, and the correct choice of adhesive is the first question. So it is necessary to find which soling materials are suitable against different types of adhesive found.

2. RESIN & CREPE RUBBER

Resin-a firm material (leather like) which has a glossy low friction surface finish. It's a very good looking soling material and also has a better quality. (2) Rubbers containing high styrene resin and over 85 IRHD (International Standard for Measuring Rubber Hardness) in hardness are classified as resin rubbers. Higher IRHD number means of high hardness. The base polymer is usually styrene-butadiene rubber, and a wide range of quality of filler/reinforcing material may be incorporated. Wear varies from good to just satisfactory, depending largely on the amount and kind of filler/reinforcing agent used. (1) Whereas crepe rubber has a translucent material with wrinkled, textured or corrugated surface. It is soft and quite rubbery with distinctive sweet smell. (2) Crepe rubber is a natural product used widely as a fashion soling material, and so its use tends to fluctuate widely. Crepe is produced by coagulating the latex from the rubber tree, forming this latex into thin sheets, and then laminating and pressing the required number of sheets together to give a specific thickness. The lighter and harder the crepe, the better it wears. At room temperature, raw natural rubber is tough although sensitive to extreme temperature, and likely to perish quickly. The first competitor of leather, crepe rubber, was superseded by vulcanized

rubbers which do not have the crepes inherent disadvantages. (1)

3. SOLE ATTACHING AND ADHESIVE

For better sole attaching a lot of key points should be considered i.e. viscosity, drying time, track retention time, sole reactivation time, green strength, bond strength, water resistance, ageing, flex resistance and heat resistance, crystallization etc. (3) The scientific study of adhesion is quite new. Although several theories have been proposed to explain the mechanics of adhesion (4), with footwear materials we need only concern ourselves with the principles of specific and mechanical adhesion. Specific adhesion gives a chemical bond between the adhesive and surfaces being joined. The adhesive, therefore, does not have to penetrate the material but is boned to the material by chemical action. (1) Whereas mechanical adhesion gives a physical bond in which the adhesive keys in to the fibers or structure of the material to be bonded. It can therefore be done only with porous material such as leather and fabrics. The mechanical theory of adhesion is a hook and eye theory. The adhesive flows into the surface structure of the material. And when the solvent in the adhesive has evaporated, the adhesive is keyed into the material. (5)

4. MATERIALS & METHODS

For my sole bonding test, I have selected the peeling strength between the sole and upper materials. The reason is that (a) it gives result in unit per area which helps to differentiate adhesives and materials also and (b) sole adhesion is for complete sole. All the materials are collected from local markets.

4.1. SAMPLE PREPARATION

For leathers and sole the sample size is same. And it is 25x125 square mm. Samples are cut according to the sizes. Keeping 40 mm on one edge, the soles are prepared by roughing and scouring. Then soles are cleaned properly. Then adhesive is applied on the sole surfaces. On the other hand, keeping 40 mm on one edge, grain sides of the leather samples are roughed properly. Then surfaces are cleaned properly. After the drying time of the adhesive, leather and soles are attached together (6). The following conditions are maintained during the preparation of sample i.e. temperature (25±2^{o}C), Relative humidity (65±2%) and the conditioning was conducted for 48 hours.

4.2. PEELING METHOD

After adjusting the testing machine one of the ends of sample is attached to one side of the machine and the other end is attached to the remaining side. After that a peeling load is applied to the machine until the samples being separated. The bond failure is observed and the load was recorded for every bond failure. For each test specimen the peeling load is divided by the width of the specimen.

A. leather samples used

B. Experiment result from resin rubber versus leather

C. Experiment result from crepe rubber versus leather

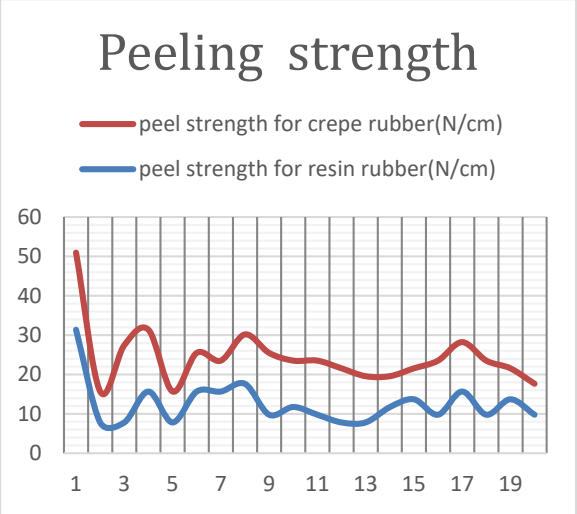
5. RESULTS & DISCUSION

Soling materials are available in a range of densities, weights, and chemical and physical properties. They may be cut from sheet, fabricated, or available in complex moldings containing several colors and types of material. The following table depicts how soling materials performs when attached to leathers by means of adhesive.

Table: Peeling Strength of Test Samples against Adhesive

SL No	Types of Soling Material	Types of upper materials	Avg. Peeling Load (kg)	Avg. Peeling Strength (N/cm)
01	Resin rubber	Light green pigment finished cow leather	8	31.36
	Crepe rubber		5	19.6
02	Resin rubber	Yellow pigment finished cow leather	2	7.84
	Crepe rubber		2	7.84
03	Resin rubber	Light blue pigment finished cow leather	2	7.84
	Crepe rubber		5	19.6
04	Resin rubber	Brown pigment finished cow leather	4	15.68
	Crepe rubber		4	15.68
05	Resin rubber	Dark red pigment finished cow leather	2	7.84
	Crepe rubber		2	7.84
06	Resin rubber	red dye finished crust cow leather	4	15.68
	Crepe rubber		2.54	9.8
07	Resin rubber	red finished buffalo leather (corrected grain)	4	15.68
	Crepe rubber		2	7.84
08	Resin rubber	blue pigment finished cow leather	4.5	17.64
	Crepe rubber		3.2	12.54
09	Resin rubber	dark green pigment finished cow leather	2.5	9.8
	Crepe rubber		4	15.68
10	Resin rubber	dark brown pigment finished cow leather	3	11.76
	Crepe rubber		3	11.76
11	Resin rubber	pink pigment finished cow leather	2.5	9.8
	Crepe rubber		3.5	13.72
12	Resin rubber	Nubuck cow leather	2	7.84
	Crepe rubber		3.5	13.72
13	Resin rubber	light brown pigment finished cow leather	2	7.84
	Crepe rubber		3	11.72
14	Resin rubber	reddish brown pigment finished cow leather	3	11.72
	Crepe rubber		2	7.84
15	Resin rubber	dark brown pigment finished buffalo leather	3.5	13.72
	Crepe rubber		2	7.84
16	Resin rubber	dark brown dye finished crust cow leather	2.5	9.8
	Crepe rubber		3.5	13.72
17	Resin rubber	dark grey pigment finished buffalo leather	4	15.68
	Crepe rubber		3.2	12.544
18	Resin rubber	black pigment finished cuff leather	2.5	9.8
	Crepe rubber		3.5	13.72
19	Resin rubber	black finished suede cow leather	3.5	13.72
	Crepe rubber		2	7.84
20	Resin rubber	black finished cow leather (corrected grain)	2.5	9.8
	Crepe rubber		2	7.84

According peel bond strength test, I found average better result by physical treatment (roughing) than doing solvent wiping. Roughing operation can help better adhesion between sole with neoprene adhesive. I found the highest bond strength for resin rubber sole 31.36 N/cm and for crepe rubber sole 19.6 N/cm.



D. Peeling Strength of resin and crepe rubber when attached in leather by means of solvent based adhesive.

6. LIMITATIONS & RECOMMENDATIONS

There is some deviation from standard value in my bonding system for some limitation. They are- (a) bonding pressure is applied by hydraulic clicking press machine (b) the pressure is applied for 20 seconds (c) problem due to some cleats in the sample (d) sole was not fully pure and (e) adhesive sometimes was not pure.

Sole bonding of upper depends on some condition's i.e. sole priming, how upper surface prepared, drying time of adhesive, adhesive reactivation and sole attaching pressure etc. (3) Considering these conditions we came to a point is that the bonding failure could be reduced by increasing sole bonding parameters, decreasing the rejection parameters or by skilling up the manpower which could possibly change the dilemma.

7. CONCLUSIONS

The accessories that currently cover our feet have 40,000 years of history. It's hard to imagine a time before the invention of shoes. Yet what started as a practical venture has grown into a varied, booming industry just as concerned with art as it is with functionality. Though all shoes share basic characteristics, their coloring, materials, and designs have transformed drastically over thousands of years in the fascinating history of footwear. So proper soling material and adhesive can enhance the quality of footwear. In our research time the highest value of resin rubber sole bonding is 31.36 N/cm and for crepe rubber sole bonding is 19.6 N/cm. The materials will show better result if there is a use of quality adhesives, primer, pure sole and or upper materials.

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