Impact of the Seam on the Properties of Technical and Nonwoven Textiles for Making Car Seat Coverings

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Abstract

The influence of the number of stitches in the seam on the joined places of car seat coverings was investigated. The properties of the fabric in seamless places were examined as well. Fabric samples include: technical fabrics, nonwoven materials, knitted fabrics, artificial leather that were cut from sewn seat covers with a different number of stitches per length unit. The following parameters of the fabric were examined: breaking force and resistance to abrasion. It was found that the characteristics of fabrics on joined places differ in the number of stitches per length unit.

Key words: woven fabric, knitted fabric, nonwoven fabric, artificial leather, penetration resistance, abrasion resistance, car seat covers, sewing, seam type, seamless

Introduction

Technical and nonwoven materials are used in many industry branches, such as motor, aircraft, furniture, catering industry etc. [1, 2].

Nowadays different types of materials are used for upholstering automobiles, whereby the application of fabrics (technical textiles such as: woven, knitted and nonwoven fabrics, natural and artificial leather) from synthetic polymers – polyester, polyamide and viscose as well as from wool and cotton in blends with synthetic fibers prevail.

For the sake of comfort more flexible and softer fabrics are used; at the same time they should be abrasion resistant and durable. They include velour and velvet woven with multicolored warp and weft yarns by applying simple types of weave or Jacquard patterns. Since these fabrics consist of a fibrous structure on the face side, the protruding fibers may be pulled out during sitting due to rubbing so that a special construction and an additional treatment are needed. Technical textiles for the motor industry shall have high elasticity that is not easily attainable with the fabric being abrasion resistant and very strong. For this reason a layer of foam is applied on the backside of the fabric and afterwards a very thin and transparent knitted fabric imparting stability, softness, elasticity and strength to the final product. Hence, woven and knitted fabrics, nonwovens and artificial leather coated with a layer of foam (a few mm thick polyurethane sponge) and a thin elastic knitted or woven fabric fixed to the foam layer is used nowadays for car seat coverings.

Special attention is given to the places of the sewn seam in the woven or knitted fabrics, especially in the warp and weft directions, so that light refraction is not different as it disturbs the appearance of the whole product.

When sewing up woven fabric attention should be paid to the warp and weft directions, and in the case of knitted fabric to the course or wale directions as well as to both ends being sewn up. Sewing direction should be in the direction of fibers. If it is not done this way, the upper layer of the fabric will be shifted. As the fabric for upholstering car seats has to meet a specific minimum strength, the joined places must have similar or almost the same properties. The properties of the joined place depend on the selected sewing thread, tension, seam type and type of joining (sewing). In most cases, if the specific strength, elasticity and abrasion resistance cannot be obtained in the sewn place, it is necessary to reinforce the seams with additional tapes and to treat them specially so that warp and weft yarns are not pulled out from the woven fab-

ric or the yarns forming the stitches from the knit fabric. By using special machines for sewing woven and knitted fabrics for upholstering car seat covers the sewer's work is facilitated and possible faults can be reduced [3-6].

Properties of materials for upholstering car seats

To make sitting in the car, sometimes for hours, as comfortable as possible and to pose the body in the correct posture, some construction standards are to be met:

- The framework of the seat should be designed firmly according to the correct posture of the body in sitting position,
- Each segment of the seat should be designed correctly and made from a material imparting safe feeling and comfortable sitting,
- The places among the segments and the places touching the body and giving the support for the body are lined with a filling material,
- The external layer is a fabric, which should have specific properties such as strength, elasticity, resistance to abrasion, pilling and inflammability, good hygroscopic properties etc.

Technical textiles such as woven and knitted fabrics enable an unlimited combination of designs and colors. They have good properties: good air permeability, humidity and warmth transfer, soft handle, good resilience, easy care, high abrasion resistance etc. In the past basic raw material for weaving and knitting were wool, then linen, cotton and other natural fibers. They are now only components in blends with synthetic fibers.

Since fabrics for upholstering should meet not only some characteristics, but also requirements, they can be separated from other fabrics. Fabric manufacture is mainly specific, and Jacquard most complex patterns are used to produce decorative effects. Among woven fabrics velvet, plush, brocade, damask and double-weft fabric and among knit fabrics plush and various Jacquard patterns are mostly used.

It is possible to make textile materials resistant to soil, water, fire etc., but they are used only for special purposes. In some countries there are legal provisions that textile materials used for upholstering furniture should be non-inflammable in public premises (ships, hotels, homes, institutions, vehicles etc.). In practice it means that they do not burn until oxygen concentration reaches 25% or that they cease burning respectively when the flame or the object heated at a high temperature is removed [7].

Woven and knitted fabrics made from a blend with cotton and synthetic fibers are used for upholstering on a broad scale because their price is lower than the price of wool products. Synthetic fibers are being used more and more in the automobile industry due to their good characteristics, e.g. strength, easily dyeable and abrasion resistance.

Polyamide fibers (Nylon and Perlon) are particularly used, while polyacrilic and propylene fibers are used as blends with natural fibers. Polyester fibers are often used in a special texture and construction imparting novel effects to woven and knitted fabrics [3-8].

Nonwovens – Since they may be engineered to have a soft hand and high elasticity, as well as being air-permeable; they are used for the sidewalls of the car seats or as lining material heat to the backside of the fabric.

Artificial leather has high abrasion resistance, but due to its discomfort (cold), low elasticity and stretch, its use is not widespread in the automobile industry.

Experimental work

Experiments were carried out on woven, knitted, non-woven materials and on artificial leather, which were intended for upholstering car seats. The sewing thread used was also tested.

Machinery and equipment used

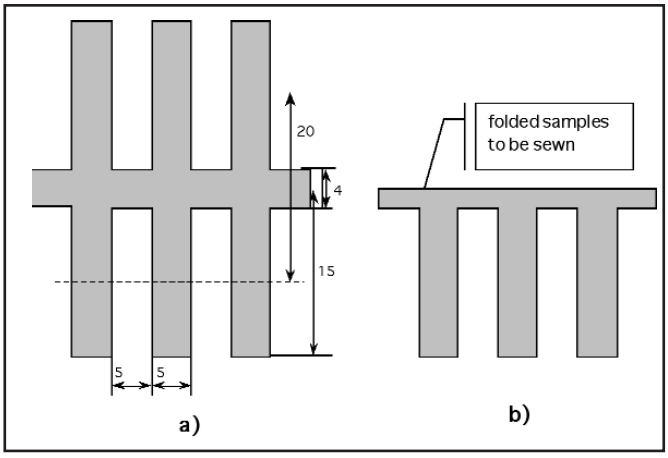
A special Pfaff sewing machine was used for sewing. Textechno tested breaking force and elongation of the thread on the dynamometer Statimat M. The Mesdan Twist tester was used to test the number of twists of the sewing thread. Yarn count was tested by winding 50 x 30 m on the winch and by weighing on an analytical electronic balance Tehtnica 2615.

Breaking force, elongation at break and fabric resistance to penetration (woven and knitted fabric, artificial leather and non-wovens) were tested on the dynamometer Apparecchi Branca S.A.: breaking force according to ASTM D 1682, and resistance to penetration according to ASTM D 3787 [9]. Abrasion resistance of the fabric to breaking was tested on the abrader Henry Baer & Co according to ASTM D 3885, whereby the number of knife revolutions till fabric break was registered.

Sewing thread and materials used

The sewing thread used was a mercerized filament 25 x 3 tex made from 100% polyester with 355 twists/m and Z-twists. Two samples of woven fabric and two samples of knitted fabric, which form the main part of the upholstered sitting seat part, as well as nonwoven fabric and artificial leather used as bonding material were tested. Technical textiles such as woven and knitted fabrics were reinforced so that a 1-2 mm thick sponge and a thin knitted fabric were fixed on the back,

Figure 1
PREPARATION OF SAMPLES WITH SEAM, WOVEN FABRIC, KNITTED FABRIC, NONWOVEN FABRIC AND ARTIFICIAL LEATHER FOR TESTING BREAKING FORCE AND ELONGATION AT BREAK



and such samples were tested. The samples of artificial leather had fixed knitted fabric on the back. The samples of nonwoven fabric are used for the back part of the seat where there is no prominent load so that they are not reinforced on the face. The samples of artificial leather and nonwovens were used for the side and back portion. The use and disposition of the material depend on the car manufacturer in meeting the quality and price demands of the consumer. All the represented materials: woven, knitted and nonwoven as well as artificial leather were examined.

The examination of breaking force, breaking elongation and resistance to penetration was carried out on all of the represented materials. The tests were carried out on samples with and without seams. The samples with seams were prepared according to *Figure 1* [9], and the seam was tested crosswise on the dynamometer used for woven fabrics. Three densities of double lockstitch in 3, 4 and 5 cm and on all fabrics were examined.

The prepared samples were 350 mm long and 60 mm wide, which was reduced to 50 mm by unraveling edge threads, standard ASTM D 1682. From each fabric 10 samples were examined in warp direction or lengthwise and 10 samples in weft direction or crosswise. The tests were carried out without seam and for each seam separately. Therefore, it was necessary to prepare 20 samples without seams for every fabric and 60 samples for 3 different seam types totaling 80 for each fabric with 320 samples overall. The samples with seams broke mostly along the seam so that breaking force is lower in the samples with seams, and this reduction resulted in a reduction of stitches/cm.

Test results

Tables 2 and 3 give the results of breaking force and elongation at break of sewing thread, woven and knit fabrics and artificial leather, and the results of resistance of these materials to abrasion and penetration are given in *Table 4*.

An adjusted dynamometer was used to determine the pen-

Table 1
PARAMETERS OF TESTED WOVEN AND KNITTED FABRICS

Tested materials	**Technical textiles**		**Knitted fabric**		**Nonwoven fabric**		**Artificial leather**	
Sample	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**
Weight (g/m^2)	298.33	304.21	309.86	414.18	567.61	139.29	766.00	765.92
Thickness (mm)	1.36	1.58	1.91	1.91	3.46	1.7	1.06	1.06
Type of weave	K 2/2	K 2/1	Plush	Plush				
Density (threads/cm)	12/12	14/12	N-12, R-10	N-12,R-10				
Count (tex)	o-20x2 p-30x2	o-25x2 p-30x2	30x2	35x2				

Notes: All of the samples are lined on the back with foam layer (2-3 cm thick polyurethane sponge and thin single jersey)
o – warp, p – weft, N – wales, R – courses

Table 2
BREAKING FORCE AND ELONGATION AT BREAK OF TECHNICAL WOVEN FABRICS, SEWING THREAD AND KNITTED FABRICS

		Breaking force of woven fabric and sewing thread						Breaking force of knitted fabric					
		F (N)		S		CV (%)		F (N)		S		CV (%)	
Samples	seam	warp	weft	warp	weft	warp	weft	wales	courses	wales	courses	wales	courses
I	(A)	1399.2	1333.1	130.96	153.44	9.36	11.51	650.3	450.1	63.79	39.70	9.81	8.82
	(B)	1449.3	1420.0	127.54	176.65	8.80	12.44	661.2	460.2	54.28	40.73	8.21	8.85
	(C)	1470.1	1467.2	116.43	151.27	7.92	10.31	671.6	530.2	55.74	49.47	8.30	9.33
	seamless	1684.2	1630.7	209.18	233.19	12.42	14.30	762.1	578.2	70.42	59.15	9.24	10.23
II	(A)	1402.1	1257.3	175.40	166.09	12.51	13.21	704.4	589.9	65.58	60.94	9.31	10.33
	(B)	1422.8	1187.4	143.85	140.35	10.11	11.82	739.1	629.5	65.78	57.35	8.90	9.11
	(C)	1489.3	1302.3	153.70	135.44	10.32	10.40	774.6	669.2	56.55	50.52	7.30	7.55
	seamless	1867.2	1621.3	256.37	237.03	13.73	14.62	880	675.8	92.84	79.20	10.55	11.72
Sewing thread		62.58		1.71		2.73							

F – average values of breaking force (N), S– standard deviation of breaking force (N), CV – correlation coefficient of breaking force (%), A – seam type (lockstitch with 3 stitches/cm), B – seam type (lockstitch with 4 stitches/cm), C – seam type (lockstitch with 5 stitches/cm)

Table 3
BREAKING FORCE OF NON-WOVEN FABRIC AND ARTIFICIAL LEATHER

		Breaking force of nonwoven fabric						Breaking force of artificial leather					
		F(N)		S_1		CV_1 (%)		I(%)		S_2		CV_2 (%)	
Samples	seam	lw	ww	lw	ww	lw	ww	lw	ww	lw	ww	lw	ww
I	(A)	620.6	611.5	26.13	31.98	4.21	5.23	265.2	241.3	12.25	12.62	4.62	5.23
	(B)	624.1	614.7	24.84	36.33	3.98	5.91	267.4	248.8	10.21	14.06	3.82	5.65
	(C)	640.6	616.5	25.62	26.01	4.00	4.22	273.1	249.6	10.38	12.46	3.80	4.99
	seamless	623.5	612.3	31.74	32.57	5.09	5.32	295.0	260.7	11.45	13.22	3.88	5.07
II	(A)	290.7	271.4	39.36	39.79	13.54	14.66	253.7	229.7	10.78	14.03	4.25	6.11
	(B)	320.4	284.5	41.91	43.56	13.08	15.31	258.5	232.5	32.39	12.53	4.07	5.39
	(C)	336.0	292.4	40.29	36.26	11.99	12.40	262.5	238.8	99.75	14.33	3.80	6.00
	seamless	310.4	281.4	57.24	37.99	18.44	13.50	280.0	241.6	41.19	14.71	4.07	6.09

lw = Lengthwise ww = Widthwise
F – average values of breaking force (N), S– standard deviation of breaking force (N), CV – correlation coefficient of breaking force (%) A – seam type (lockstitch with 3 stitches/cm), B – seam type (lockstitch with 4 stitches/cm), C – seam type (lockstitch with 5 stitches/cm)

etration of the fabric. The samples were prepared in such a way that circles of 5 cm in diameter were cut out. They were placed in a ring and fixed on the border. Under the fabric a ball on a metal rod was moved upward until it penetrated the fabric completely. At the moment of penetration force and elongation of the fabric were registered.

The abrader made by Henry Baer&Co was used to examine abrasion resistance of the fabric. Samples of the fabrics were prepared in the same way as for the dynamometer with final dimensions of 350 mm x 50 mm. The clamps of the abrader fastened the prepared sample. The lid with the prepared sample was placed on the knives, and then loaded with 0.5 kg according to the standard HRN F.S2.024. The knives are arranged along the circumference of the shaft and by rotating they abrade the fabric. When the fabric breaks or tears, the frame falls down, switching off the device. The counter shows the number of revolutions of the knives, and this number of revolutions was taken as a measure of fabric abrasion resistance.

Discussion

The test results of the fabrics for use in motorcars are as follows: Average breaking force and breaking elongation of the sewing threads are given in *Tables 2 to 4* and *Figures 2 to 7*.

Breaking force of the sewing thread and fabrics

The average breaking force of the sewing thread is 62.58 N; the test results are given in *Table 2* and *Figure 2*. Woven fabric I has a little higher breaking force than fabric II referring to the samples with and without seam in the warp and weft directions *(Table 2, Figure 2)*. On the basis of the results it is evident that the breaking force of the seamless samples is higher for both tested fabrics. The samples with seam differ in the number of stitches, so that in fabric I the breaking force in warp direction with the lowest number of stitches/cm is 1399.2 N, with the highest number of stitches/cm is 1470.1 N, and without seam 1684.2N. The breaking force of the same fabric with seam and in weft direction is from 1333.1 N to 1467,2 N, and without seam 1630.7 N. The breaking force of fabric II in warp direction is from 1402.1N with the lowest number of stitches/cm to 1489.3 N with the highest number of stitches/cm, whereas the breaking force of the seamless samples is 1867.2 N. The breaking force of the same fabric with seam in weft direction is from 1257.3 N to 1302.3 N, and in the seamless samples 1621.3N. The breaking force of the knitted fabric is shown in *Table 2* and *Figure 2*. According to the obtained results the breaking force in wales is higher than in courses in all tested samples. Knitted fabric I has a higher breaking force in wales in the seamless samples, being 762,1 N, and in the samples with seam from 650,3 N to 671,9 N. In courses the same knitted fabric with seam has a breaking force from 450,1 N to 530,2 N. In wales knitted fabric II with seam has a breaking force from 704,4 N to 774,6 N and without seam 880 N. In courses the same fabric with seam has a breaking force from 589,9 N to 669,2 N, and without seam 675,8 N.

The average values of the breaking force of the nonwoven-fabric are given in *Table 3* and *Figure 3*. According to the obtained results of the breaking force it can be concluded that it rises with increasing the number of stitches/cm for all samples lengthwise and widthwise. The samples of nonwoven fabric I with seam have a breaking force of 620,6 N to 640,6 N in the direction of the length, and a breaking force of 611,5 N to 616,5 N in the direction of the width. It is worth mentioning that the breaking force of the seamless samples is not higher of the breaking forces of the samples with seam, as was the case with woven and knitted fabrics and artificial leather.

Table 4
RESISTANCE OF THE FABRIC TO ABRASION AND PENETRATION

			Penetration resistance						Abrasion resistance			
Fabric		**Samples**	**X (n)**	**S**	**CV (%)**	**I (%)**	**S**	**CV (%)**		**N (n)**	**S**	**CV (%)**
Technical fabric	I	seamless	1680.6	197.13	11.73	8.06	0.70	8.71	Wa	867	90.43	10.43
									We	587	78.01	13.29
		with seam	1109.6	119.39	10.76	11.15	0.86	7.67	Wa	787	65.40	8.31
									We	545	63.11	11.58
	II	seamless	1877.3	257.19	13.70	9.70	0.87	8.99	Wa	902	80.46	8.92
									We	608	60.62	9.97
		with seam	1467.2	148.04	10.09	6.81	0.45	6.67	Wa	891	82.95	9.31
									We	557	57.65	10.35
Knitted fabric	I	seamless	840.7	89.20	10.61	7.97	0.74	9.31	Wd	381	43.09	11.31
									Cd	268	36.96	13.79
		with seam	721.4	66.51	9.22	5.69	0.51	8.89	Wd	231	24.65	10.67
									Cd	133	19.44	14.62
	II	seamless	960.6	109.80	11.43	7.15	0.59	8.32	Wd	696	81.08	11.65
									Cd	487	70.71	14.52
		with seam	880.9	81.13	9.21	6.61	0.61	9.23	Wd	599	74.10	12.37
									Cd	421	63.15	15.00
Nonwoven fabric	I	seamless	1120	76.27	6.81	6.2	0.54	8.67	L	389	51.70	13.29
									C	253	42.43	16.77
		with seam	1105	63.10	5.71	5.32	0.28	5.21	L	372	57.03	15.33
									C	186	26.43	14.21
	II	seamless	610	26.17	4.29	5.84	0.40	6.89	L	119	13.71	11.52
									C	89	12.37	13.90
		with seam	589	30.69	5.21	5.31	0.22	4.22	L	128	18.32	14.31
									C	74	11.90	16.08
Artificial leather	I	seamless	460	17.39	3.78	6.00	0.16	2.67	L	1291	115.03	8.91
									C	1093	106.79	9.77
		with seam	310	13.08	4.22	5.12	0.10	2.01	L	1094	104.26	9.53
									C	878	65.32	7.44
	II	seamless	430	15.70	3.65	5.72	0.17	3.05	L	1521	173.70	11.42
									C	1389	147.79	10.64
		with seam	283	10.78	3.81	4.99	0.15	3.00	L	1320	123.02	9.32
									C	1289	151.72	11.77

X – average value (n), S – standard deviation, CV – variation coefficient (%), N – number of knife revolutions until fabric break (revolutions/fabric breakage) (n), O – in warp direction, P – in weft direction, Wd – in wale direction, Cd – in course direction, L – lengthwise, C – widthwise

The samples of nonwoven fabric II have a substantially lower breaking force than sample I, and they differ in other properties, such as thickness and specific mass. The breaking force of sample II with seam is from 290,7 N to 336 N lengthwise, and from 272,4 N to 292,4 N widthwise. In samples)) it is also perceptible that the seamless samples do not have a higher breaking force than the samples with seam.

The breaking force of the artificial leather is illustrated in *Table 3* and *Figure 3*. Since the face of the artificial leather shows no difference in the directions of length and width, the fixed knitted fabric on the back of the artificial leather served a purpose. The artificial leather was examined in course and wale directions. The wale direction was length direction and the course direction was width direction. The samples of artificial leather I with seam in the direction of the length differ in stitch length, and the higher the number of stitches/cm, the higher is the breaking force, and it is from 265.2 N to 273.1 N. The breaking force of the tested samples of the artificial

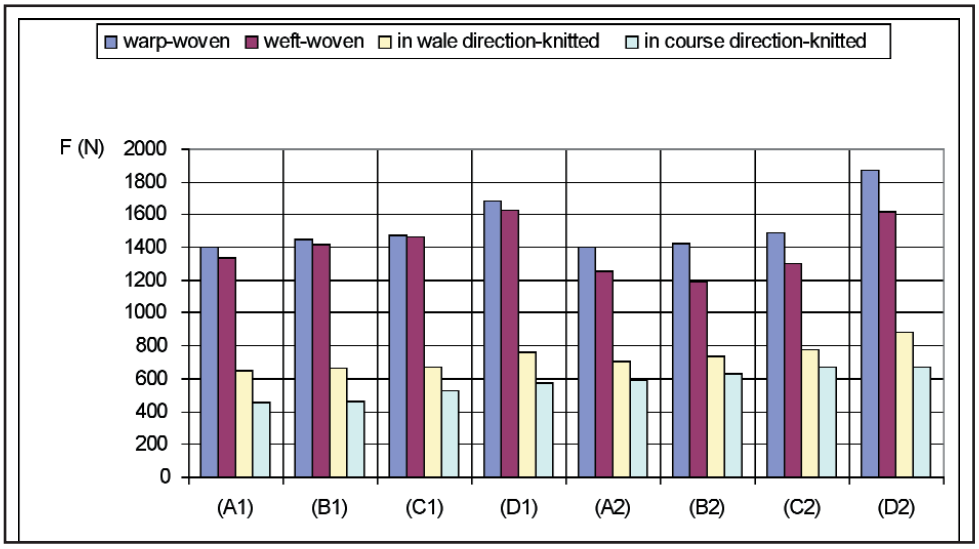
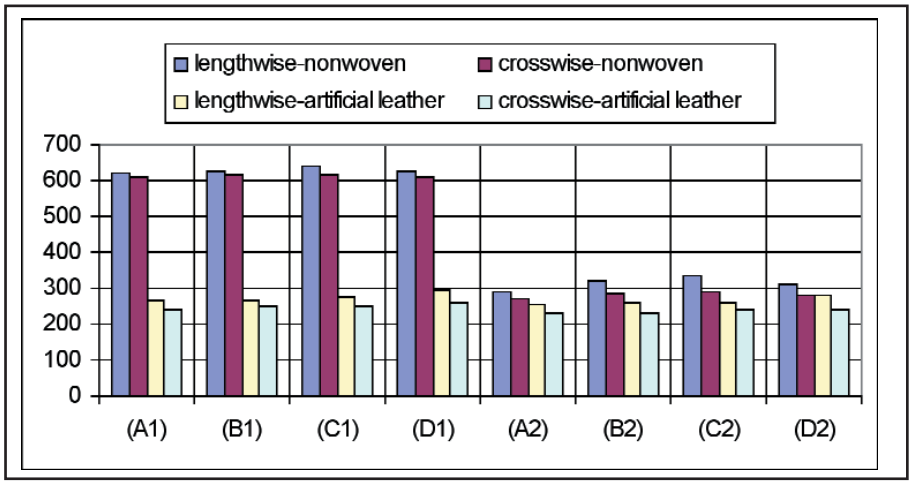


Figure 2
IG. 2 BREAKING FORCE OF THE TECHNICAL TEXTILE AND KNITTED FABRIC WITH AND WITHOUT SEAM IN WARP AND WEFT DIRECTIONS

A1 – fabric sample with seam (3 stitches/cm) in warp and wale directions, A2 – fabric sample with seam (3 stitches/cm) in weft and course directions, B1 – fabric sample with seam (4 stitches/cm) in warp and wale directions, B2 – fabric sample with seam (4 stitches/cm) in weft and course directions, C1 – fabric sample with seam (5 stitches/cm) in warp and wale directions, C2 – fabric sample with seam (5 stitches/cm) in weft and course directions, D1 seamless fabric sample in warp and wale directions, D2 – seamless fabric sample in weft and course directions

Figure 3
BREAKING FORCE OF THE NONWOVEN FABRIC AND ARTIFICIAL LEATHER WITH AND WITHOUT SEAM LENGTHWISE AND WIDTHWISE

A1 – sample with seam (3 stitches/cm) lengthwise, A2 – sample with seam (3 stitches/cm) widthwise, B1 – sample with seam (4 stitches/cm) lengthwise, B2 – sample with seam (4 stitches/cm) lengthwise, C1 – with seam (5 stitches/cm) lengthwise, C2 with seam (5 stitches/cm) lengthwise, D1 – seamless lengthwise, D2 – seamless widthwise



leather with seam is from 241.3 N to 249.6 N. The breaking force of artificial leather II with seam is from 253.7 N to 262.5 N lengthwise, and from 229.7 to 238.8 N widthwise. The breaking forces of the seamless samples are higher, and for sample I it is from 295 N lengthwise, and 260.7 N widthwise. The breaking force of sample II is 280 N lengthwise and 241.6 N widthwise.

The penetration resistance of fabrics is illustrated in *Table 4* and *Figure 4*. The samples without seam and with one seam and with 5 stitches/cm were tested.

The obtained results of testing the penetration of the seamless woven fabrics are from 1680.6 N (sample I) to 1877.3 N (sample II), and for the fabrics with seam from 1109.6 N (sample I) to 1467.2 N (sample II). The breaking elongation of both samples is from 6.81% to 11.15%.

The results of testing the penetration of the seamless knitted fabrics are from 840.7 N (sample I) to 960.6 N (sample II), and the results for the samples with seam are from 721.4 (sample I) to 880.9 N (sample II). The breaking elongation is similar for both samples, and it is from 5.69% to 7.97%, but it is somewhat higher for the seamless samples.

The average values of testing the penetration of the nonwoven fabric differ, sample I has a noticeably higher penetration resistance. The obtained results for the samples without seam are from 610 N (sample II) to 1120 (sample I), and for the samples with seam from 589 N (sample II) to 1105 N (sample I).

The average values of testing the penetration of the seamless artificial leather are from 430 N (sample II) to 460 N (sample I), and for the artificial leather with seam from 283 N (sample II) to 310 N (sample I). The Breaking elongation is similar for both samples, and it is from 4.99% to 6%.

The testing of fabric abrasion resistance is illustrated in *Table 4* and *Figure 5*. Seamless samples were tested lengthwise and crosswise as well as samples with seam having 5

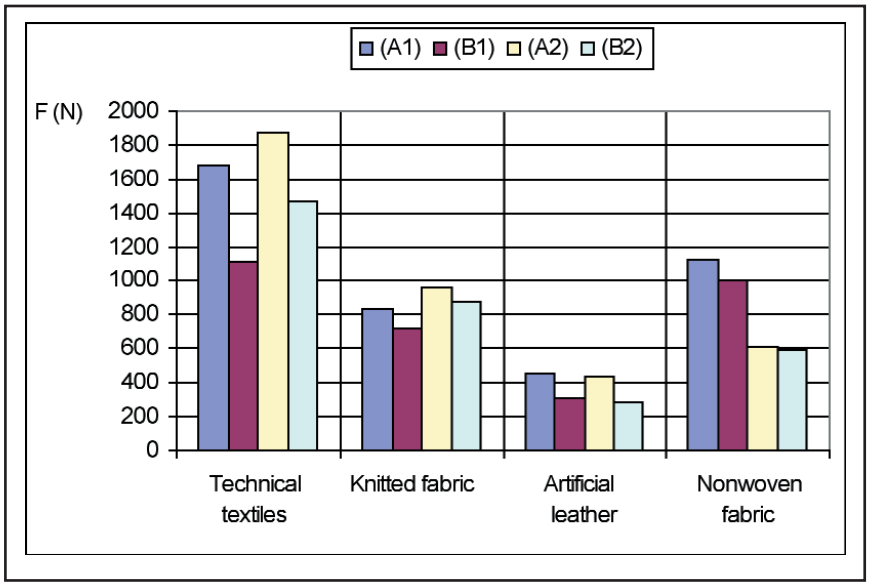


Figure 4
PENETRATION RESISTANCE OF FABRICS
A1, 2 – fabric sample (1,2) seamless, B1, 2 – fabric sample (1,2) with seam

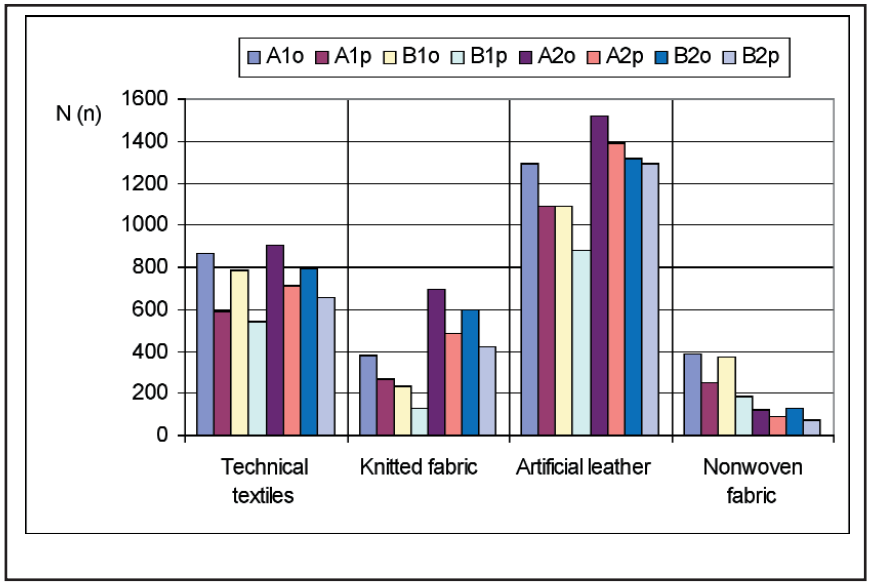


Figure 5
ABRASION RESISTANCE OF FABRICS
N – number of knife revolutions (n), A1, 2 – fabric sample (1,2) seamless in warp (o) and weft (p) directions, B1, 2 – fabric sample (1,2) with seam in warp (o) and weft (p) directions

stitches/cm, also in both directions. The average values of testing both seamless woven fabric samples in the warp direction are from 867 N to 902 N, and from 587 N to 608 N in the weft direction. The values obtained for the samples with seam in the warp direction are from 787 N to 891 N, and from 545 N to 557 N in the weft direction.

The values obtained by testing the abrasion resistance of the seamless knitted fabrics in the wale direction is from 381 N to 696 N, and from 268 N to 487 N in the course direction, and for the fabric with seam in the wale direction from 231 N to 599 N and from 133 N to 421 N in the course direction.

The average values of testing the abrasion resistance of the seamless nonwoven fabric lengthwise is from 119 N to 389 N, and of the seamless nonwoven fabric widthwise from 89 N to 253 N, with seam lengthwise from 128 N to 372 and with seam widthwise from 74 N to 186 N.

The results of testing the abrasion resistance of the seamless artificial leather lengthwise are from 1291 N to 1521 and widthwise from 1093 N to 1389, with seam lengthwise from 1094 N to 1320 N and widthwise from 878 N to 1289 N.

Establishing the average values of breaking forces and abrasion resistance of the woven fabrics, it is discernible that the values of these fabrics show a relatively narrow range of scattering values and that they get into the defined range *(Figure 6)*. According to this range certain criteria may be determined which fabrics for upholstering car seats are to meet.

In *Figure 7* the relationship between breaking forces and abrasion resistance of the knit fabrics is discernible. Comparing this diagram with the diagram for the woven fabrics a broader range of scattering values may be perceptible in knitted fabrics, and their resistance to breaking forces and abrasion resistance is considerably lower than in woven fabrics.

Conclusions

By testing textile fabrics for the automobile industry the following conclusions were reached:

Technical woven fabric represents the strongest textile fabric with the highest breaking force and highest penetration resistance.

The advantage of knitted fabric is not its strength but elasticity and softness what makes it more comfortable than woven fabric, but due to its considerably lower abrasion resistance and lower breaking force its durability compared with woven fabric and artificial leather is shorter.

Artificial leather has the highest abrasion resistance, but due to its low elongation penetration resistance and breaking force did not produce good results. Artificial leather is especially durable, but its coldness, discomfort and poor elasticity as well as high price are the reasons why the automobile industry prefers woven and knitted fabrics. However, artificial leather is used for combinations with other fabrics, and it

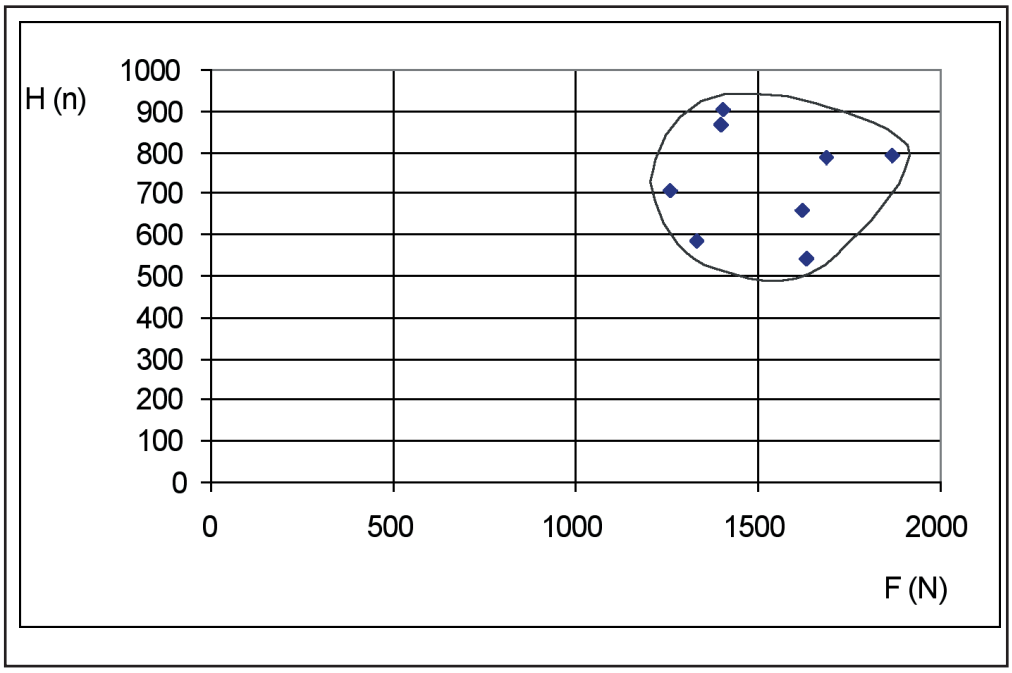


Figure 6
FIG. 6 RELATION OF BREAKING FORCE AND ABRASION RESISTANCE OF TECHNICAL TEXTILES
F – breaking force of fabric (N), H – abrasion resistance of fabric (n = number of knife revolutions until fabric breakage)

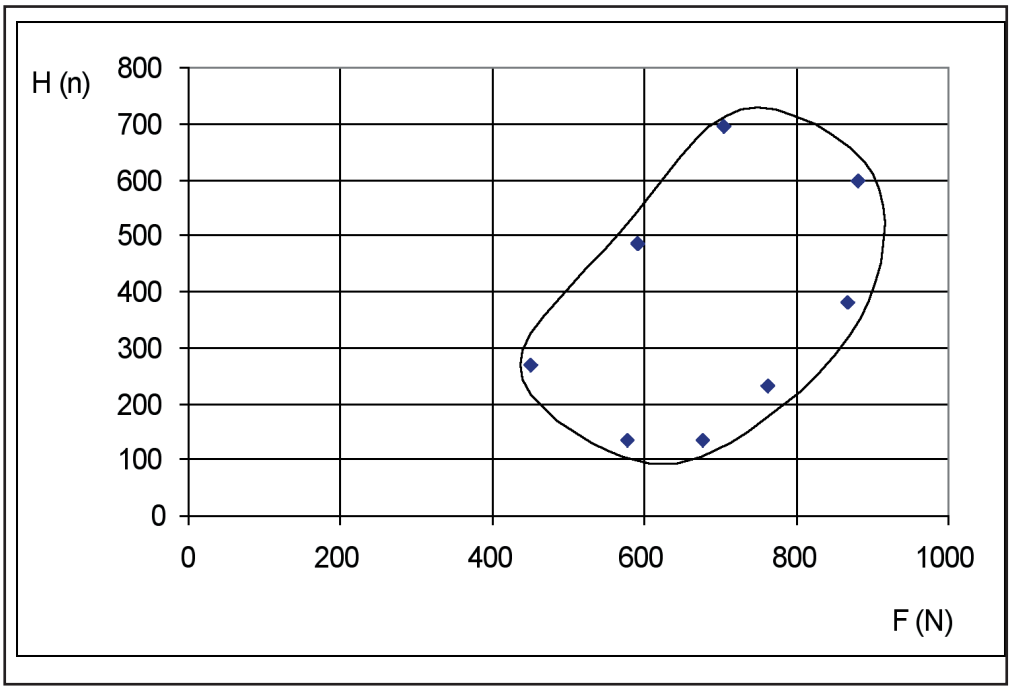


Figure 6
RELATION OF BREAKING FORCE AND ABRASION RESISTANCE OF KNITTED FABRIC
F – breaking force of knitted fabric (N), H – abrasion resistance of knitted fabric (n = number of knife revolutions until fabric breakage)

is irreplaceable to maintain side seat portions.

Seamless samples had higher breaking forces, higher abrasion and penetration resistance in almost all fabrics. Their weakening in testing happened just in the seam. Nonwoven fabric makes an exception because in one sample it has a higher breaking force, namely in one with the densest stitches.

Since the fabric became weaker along the seam in all tests and samples, it may be asserted that one of the reasons may be a lower strength of the sewing thread and the strength of the thread should be connected with the strength of the fabric to be sewn.

Nearly in all tests and samples the test results were better for the samples having shorter stitches with a higher number of stitches/cm. The results for the seamless samples were better, following the samples with the densest stitches (5 stitches/cm), then the samples with the medium stitch density (4 stitches/cm) and finally the samples with the lowest density (3 stitches/cm). It leads to the conclusion that stitch density represents the most important parameter affecting the examined values. It was not tested which stitch density may be applicable, but on the basis of the obtained results the upper limit is nearly reached, since the increasing number of stitches did not cause a linear increase of values.

The ratio between woven fabric breaking forces and woven fabric abrasion resistance has a small range of scattering values.

The ratio between knitted fabric breaking forces and knitted fabric abrasion resistance has a wider range of

scattering values in relation to woven fabric.

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