RESEARCH NOTE

SHEARING PROPERTIES OF THE SKEWED WOVEN FABRICS

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Abstract This experimental work deals with the effects of skewness on the shearing properties of the worsted woven fabric. Shearing properties of 160 samples are measured by two methods (KES and concentrated loading methods) and the results are compared. Both methods show a positive correlation between skewness and shear rigidity indicating, as the skewness goes up the shear rigidity also increases. Correlation between shear rigidity evaluated by KES and skewness was 0.725, but new parameter (EML) extracted from the concentrated loading curve (Extension at 200 gram-load) showed more sensitivity to fabric skewness and gave a higher correlation (-0.866) to it. In other words, the concentrated loading method shows the relationship between skewness and the shear rigidity (G).

Keywords Skewness, Shear rigidity, Concentrated loading method, KES method, Fabric deformation

چکیده این کار تجربی، مرتبط با اثرات سرکجی بر روی خواص برشی پارچه‌های فاستونی (از نوع تاری - پودی) است. خواص برشی ۱۶۰ نمونه پارچه فاستونی از طریق دو روش کاواباتا و نیروی متمرکز اندازه‌گیری و نتایج باهم مقایسه گردیده است. هر دو روش، همبستگی مثبت بین سرکجی و مقاومت برشی نشان داده‌اند به این معنی که هر چه سرکجی در پارچه افزایش یابد مقاومت برشی نیز افزایش می‌یابد. همبستگی بین سرکجی و مقاومت برشی ارزشیابی شده توسط روش کاواباتا ۰/۷۲۵ است. درحالیکه، (EML) پارامتر گرفته شده از منحنی روش نیروی متمرکز، حساسیت بیشتری نسبت به سرکجی نشان داده و همبستگی ۰/۸۶۶ ارائه داده است.

1. INTRODUCTION

Woven fabrics are constructed with lengthwise (warp) and crosswise yarns (weft) interlaced at right angles. Skewness in woven fabric is a condition where the warp and weft yarns, although straight, are not at right angles to each other [1] (Fig.1).

Skewness causes difficulties during tailoring, sewing and three-dimensional forming process. Garments made from skewed fabric may behave differently on each part of the body and as a result lose the proper body shape. This work investigated the relationship between fabric skewness and the shearing property of the worsted woven fabrics.

Skewness can occur in warping, weaving and finishing processes. The main cause at any step of the finishing process is the variation in running speed across the width of the fabric. In finishing process, skewness often occurs when wet fabric is attached to chain driven tentering frames and run through a heated oven. Fabric will become skewed

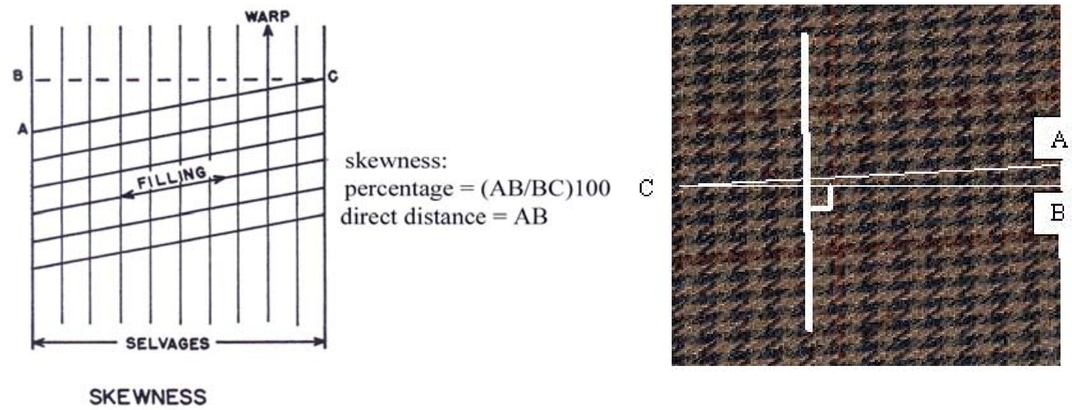


Figure 1. Fabric skewed

if it is attached to the frames so that the filling yarns are pulled off the 90-degree alignment or if the chains on either side move at different speeds. However, skewness takes place through the mechanism of fabric shear as the warp and filling yarns rotate at the intersections from a right angle position to form obtuse or acute angle.

During the process of fabric forming, the main element causing such problem is tension variations across the width of the warp beam [2]. In case of sectional warping, improper slope or tension applied to each band of warp can cause skewness [3].

Fabric skewness is common, and because it is difficult to control in the production process, the amount may vary within continuous yardage. Textile producers try to avoid this problem especially in the case of high quality fabrics, and to help alleviate it, automatic weft straightening devices are used during the finishing processes [4]. However, no mandatory standards are used by the industry to define excessive fabric skewness. The Worth Street Textile Rules [5] state that tolerances of 2.5% to 3% of the fabric width are reasonable. Powderly [6] believes for some fabrics more restrictive standards should be required. Skewness is expressed as a percent of the greatest distance of angularity displacement from a line of the fabric divided by the width of the fabric.

A literature search revealed a paucity of studies on skewness in woven fabrics. No studies were found that investigated the effects of skewness on shearing properties of woven fabrics. The only work done on the drape [7] shows that the properties of woven fabrics are effected by the skewness. However, when woven fabric shear is measured, the hysteresis diagram is generally symmetric because the fabric is sheared at the same angle to left and to right. But when the yarns are not at right angles hysteresis will be asymmetric [8].

2. MATERIALS AND MESSUREMENTS

2.1. Materials

A fabric manufacturer induced different levels of skewness into each of ten 60-meter rolls of woven fabric. The fabrics were gray but the yarns were dyed (no finishing treatment was done on the fabrics).

Table 1. Specification of the fibers and produced yarn.

Material used	Yarn specification		
	Twist/meter		Nm
	Single	Plied	
1- Australian merino fleece wool top as per international standard (IWTO) Wool specification: 22 micron (maximum average), 65 mm (minimum average), sliver weight 20 gr/m	600 (Z)	550 (S)	48/2
2- Dupont Polyester Tops, 20gr/m Polyester tops, 3 den, 76 mm, raw white, semi dull, low pilling			

They were all, 2/2-twill weave, 28 warp/cm, 22 weft/cm and 1.5-meter width, woven on the Dornier SW5 weaving machine (200 picks per minute) at the condition of 65% R. H. and 22° C.).
Warp and filling yarns were the same and were made of 45% wool 55% polyester with the specification shown in Table 1

2.2. Measurements

2.2.1 Skewness

Fabric skewness was measured according to ASTMD-3882-88 test method [9]. Based on the level of skewness, the fabrics were cut, ranged and labeled so that a total of 160 sets of samples (3 pieces per each level of skewness) were ready to be tested.

2.2.2 Shearing

a) Concentrated loading method [10]

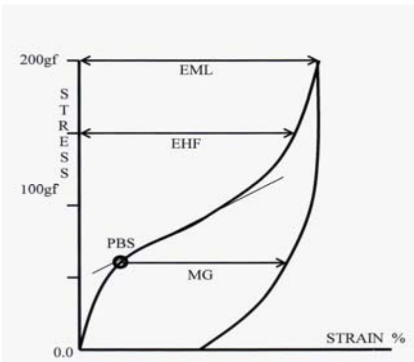
After 24 hours of conditioning (65% RH and 22 ° C), a rectangular specimen 24cm long and 5cm wide was cut from every sample fabric, at angle of 45° to the warp direction, (which is the same to the weft direction) using a special template. The strip is then folded in half to form a double ply of face to face fabrics 12-cm. long. The puncher inserts an eyelet 1-cm from the ply ends opposite to the fold and the second eyelet is inserted 10-cm far from the first one after possible slack is removed. (Doubling the strip makes the samples free from any shear strain, which could be developed under tensile stress).
The samples were then subjected to a single loading-unloading cycle at a rate of 10 mm/min with a 200g maximum force using a simple attachment to the jaws of Testometric-micro 350 made in the Shirly developments, with 10 kg load cell.

Features of the Loading unloading curve

Fig. 2 shows a typical load extension curve of the concentrated loading method and the parameters extracted from the curve.

b) KES method

Shearing behavior of the samples was also measured on Kawabata Tensile and Shear tester-FB1 according to the testing instructor manual [12]. The results from the two methods are shown in Appendix I.



Sym.	Parameters	Unit
PBS	Slope at critical point [11]	.gf
EML	Strain at 200-gram load	%
EHF	Strain at 150-gram load	%
MG	Maximum distance (strain) between loading-unloading curves	%

Figure 2. Typical load extension curve of the Concentrated Loading Method.

3. RESULTS AND DISCUSSION

Table 2 shows the correlation coefficient between skewness and the parameters measured by the two methods. The results show a direct relationship between skewness and shearing rigidity (G). That is, as the skewness goes up, the shearing rigidity increases.

Shear rigidity is dependent upon the relationship between warp and weft at the joint points. In other words, shearing rigidities varies depending upon how tight the two yarns (warp and weft) are in contact. As the warp and weft bed into each other at joint point, the friction force between them is high and as a result shearing rigidity is increased.

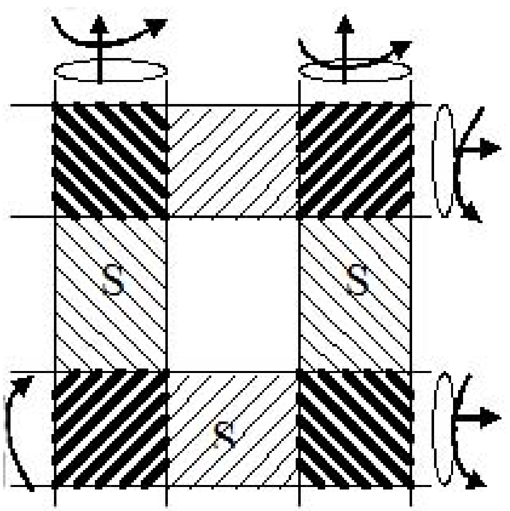


Figure 3. Contact point and the twist direction

As an example when the twist direction for warp and weft is the same, the twist on the underside of the top thread is in the same direction as that on the upper side of the lower thread (Fig. 3). Such condition is favourable for the threads to bed into each other and form a compact cloth in which the weave and thread structure are not distinct. Naturally such case leads to have higher shearing rigidity, giving a lower degree of freedom to the yarn movement.

It is also obvious that as the tension (warp and weft) during the weaving process goes high the compactness at crossing point is also higher and as a result shearing rigidity is increased. So due to the following facts the direct relation between skewness in woven fabric and shearing rigidity can be explained and accepted.

- In a weft skewed fabric, filling yarns cover a longer pass (at constant length) and as a result the tightness at crossing point is higher.
- Skewed yarns expand crossing point area and cause the yarns and fibres to be more in touch and contact to each other and increase the friction forces between the yarns.

Table 2 also shows a high correlation of -0.866 between skewness and EML extracted from the loading-unloading curve of the Concentrated Loading Method.

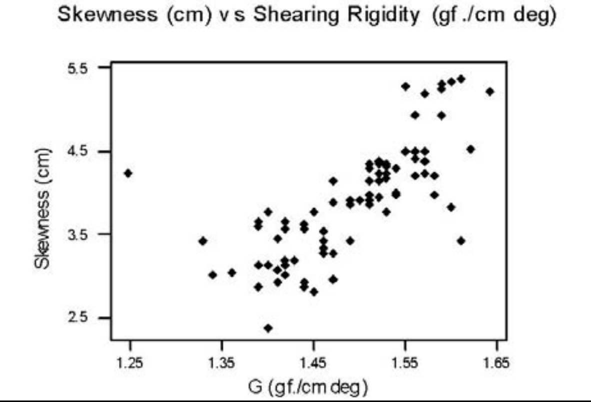
The difference between the KES and the Concentrated Loading Method indicates the sensitivity of the last method. The cause of such difference between the two methods is due to manner of the deformation.

No doubt that Shearing rigidity is caused mainly by the resistance against change of the interlacing angle, which is caused by friction and some elastic restriction to the rotation of the interlacing angle between the warp and weft yarns.

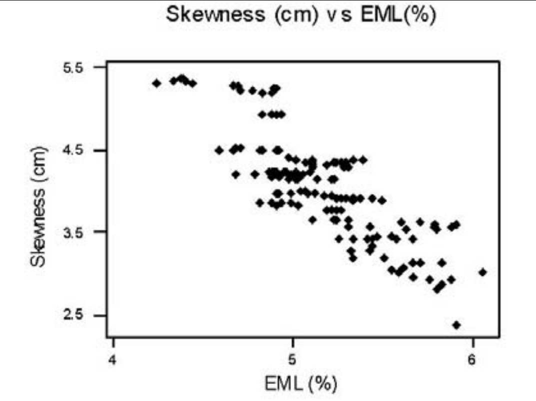
Shearing deformation mode adopted in the KES-FB testing system, (Fig 5) is based on interlacing angle change, (yarns are almost straightened by pre-tension load inserted). This type of deformation shows the force needed to overcome the friction between yarns especially at contact point.

Table 2. Correlation coefficients between Skewness & Shearing properties.

	KES shearing parameters			Concentrated loading method			
	G	HG.5	HG5	EHF	PBS	MG	EML
Skewness	0.725	0.787	0.744	-0.712	0.561	-0.754	-0.866



a) Kawabata Evaluation System



a) Concentrated Loading Method

Figure 4. The plots of skewness verses the shearing parameters

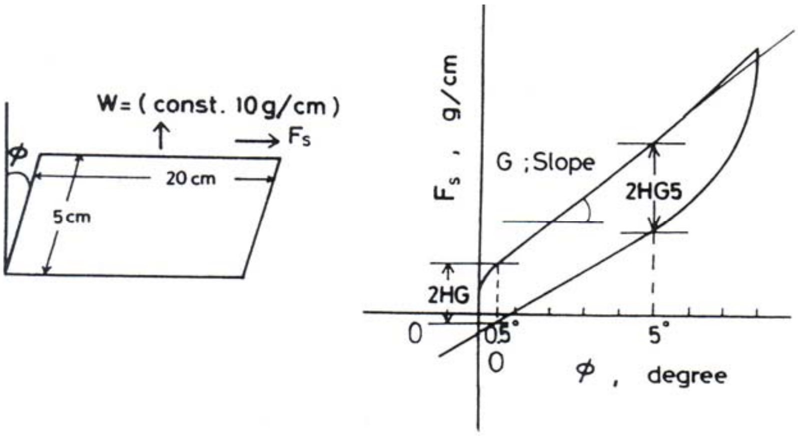


Figure 5. Shearing deformation modes (Kawabata Evaluation System)

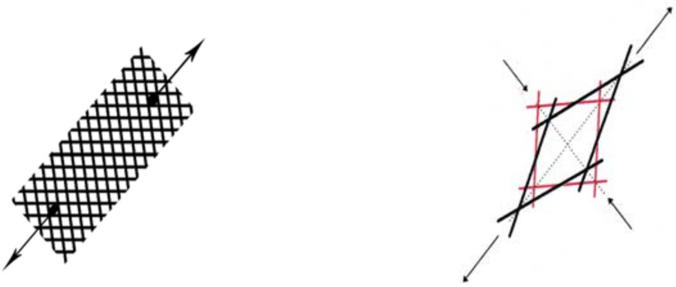


Figure 6. Shearing deformation modes (Concentrated Loading Method)

In the case of concentrated loading method, the deformation is completely different (Fig. 6). It contains yarn compression and straightening, yarn movement and slippage at contact point, and angle change. Therefore, the final extension (EML) contains the maximum possible configuration change which includes warp and weft straightening, yarn slippage or movement (at the cross points toward the center of the rectangular), and movement or possible slippage of the fibers inside the yarns. The negative sign of the correlation value (between Skewness & strain at 200 gram force) indicates that as the value of the skewness raises the value of the extracted feature (EML) decreases. This means that as the skewness increases the chance for yarns to move and rotate on each other is decreased.

4. CONCLUSION

1. Shearing behavior is related to the warp and weft alignment so that, as the skewness increases the shearing rigidity also increases.
2. Correlation between skewness of the fabrics and the maximum extension of the concentrated loading curves denotes that the behavior of the fabric due to tensile load is affected by the skewness.
3. Concentrated Loading Method could be a valuable tool to evaluate the shearing properties of the woven fabrics. In addition, textile producers can take the advantage and use this method to control the effect of the production parameters on the quality of their woven fabric products.

5. ACKNOWLEDGEMENT

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Appendix:

Skewness	Kawabata Eva.System			Concentrated Loading Method					
Cm	G	HG.5	HG5	EML	EHF	MG	PBS	Fw.gr	Art. no
2.38	1.40	1.900	3.880	5.900	4.890	2.780	34.130	360	5525
	1.40	1.990	4.990	5.900	4.890	2.780	34.130	360	5525
2.80	1.45	1.960	4.440	5.800	4.660	2.730	36.100	370	5418
	1.45	2.040	4.580	5.800	4.660	2.730	36.100	370	5418
2.87	1.44	1.980	3.990	5.830	4.280	2.740	35.700	367	5440
	1.44	2.310	4.050	5.830	4.280	2.740	35.700	367	5440
2.88	1.39	1.920	4.210	5.820	4.430	2.630	35.660	360	5441
	1.39	2.020	4.390	5.820	4.430	2.630	35.660	360	5441
2.92	1.41	1.990	4.380	5.760	3.930	2.700	35.880	362	5466
	1.41	2.120	4.700	5.760	3.930	2.700	35.880	362	5466
2.93	1.44	2.050	4.100	5.880	4.180	2.730	36.010	360	5391
	1.44	2.200	4.320	5.880	4.180	2.730	36.010	360	5391
2.96	1.47	2.120	4.600	5.660	4.330	2.710	36.100	365	5483
	1.47	2.230	4.750	5.660	4.330	2.710	36.100	365	5483
3.00	1.42	2.110	4.500	5.590	3.870	2.730	36.500	362	5392
	1.42	2.320	4.750	5.590	3.870	2.730	36.500	362	5392
3.00	1.34	2.080	4.240	6.050	4.330	2.710	36.890	367	5480
	1.34	2.120	4.140	6.050	4.330	2.710	36.890	367	5480
3.03	1.36	1.920	3.880	5.550	3.680	2.680	36.600	370	5489
	1.36	2.100	4.080	5.550	3.680	2.680	36.600	370	5489
3.06	1.41	1.980	4.300	5.610	3.970	2.730	36.730	380	5492
	1.41	2.100	4.530	5.610	3.970	2.730	36.730	380	5492
3.12	1.42	2.170	4.150	5.660	4.300	2.680	36.780	372	5504
	1.42	2.320	4.500	5.660	4.300	2.680	36.780	372	5504
3.14	1.40	2.200	4.280	5.830	4.810	2.660	35.130	362	5505
	1.40	2.310	4.510	5.830	4.810	2.660	35.130	362	5505
3.14	1.39	2.130	4.320	5.700	4.630	2.910	32.600	360	5510
	1.39	2.200	4.600	5.700	4.630	2.910	32.600	360	5510
3.18	1.43	2.330	4.490	5.330	4.460	1.990	33.610	362	5514
	1.43	2.500	4.510	5.330	4.460	1.990	33.610	362	5514
3.18	1.42	2.180	4.350	5.500	4.880	2.160	34.660	362	5519
	1.42	2.300	4.590	5.500	4.880	2.160	34.660	362	5519
3.26	1.47	2.120	4.600	5.320	4.730	2.190	36.990	367	5395
	1.47	2.220	4.860	5.320	4.730	2.190	36.990	367	5395
3.28	1.46	2.270	4.630	5.420	4.330	2.830	36.740	360	5546
	1.46	2.380	4.890	5.420	4.330	2.830	36.740	360	5546
3.32	1.46	2.210	4.660	5.440	4.380	2.440	35.900	350	5526
	1.46	2.300	4.900	5.440	4.380	2.440	35.900	350	5526
3.42	1.49	2.290	4.700	5.330	4.330	1.920	36.600	360	5394
	1.49	2.360	4.800	5.330	4.330	1.920	36.600	360	5394
3.42	1.33	2.220	4.590	5.410	4.160	2.040	37.400	360	5401
	1.33	2.410	4.780	5.410	4.160	2.040	37.400	360	5401
3.42	1.61	2.310	4.800	5.250	4.320	2.470	41.800	367	5397
	1.61	2.440	5.300	5.250	4.320	2.470	41.800	367	5397
3.43	1.49	2.280	4.850	5.440	4.010	1.990	38.600	360	5402
	1.49	2.260	5.100	5.440	4.010	1.990	38.600	367	5402
3.43	1.46	2.320	4.900	5.570	4.090	2.010	36.200	360	5527
	1.46	2.500	5.130	5.660	4.090	2.010	36.200	360	5527
3.44	1.41	2.270	4.980	5.460	4.020	1.980	36.110	360	5399
	1.41	2.400	5.170	5.550	4.020	1.980	36.110	360	5399
3.54	1.46	2.330	4.580	5.630	4.250	2.110	35.140	370	5430
	1.46	2.500	4.800	5.800	4.250	2.110	35.140	370	5430
3.55	1.44	2.300	4.680	5.880	4.290	2.180	34.600	370	5432
	1.44	2.510	4.900	5.790	4.290	2.180	34.600	370	5432
3.56	1.42	2.310	4.970	5.310	4.060	2.040	37.900	377	5439
	1.42	2.500	5.250	5.420	4.060	2.040	37.900	377	5439
3.60	1.39	2.390	4.880	5.900	4.420	2.110	32.300	362	5448
	1.39	2.440	5.100	5.790	4.420	2.110	32.300	362	5448

Continuation of the appendix

Skewness	Kawabata Eva.System			Concentrated Loading Method					
Cm	G	HG.5	HG5	EML	EHF	MG	PBS	Fw.gr	Art. no
3.61	1.44	2.400	5.100	5.700	4.130	2.160	35.100	367	5451
	1.44	2.520	5.330	5.600	4.130	2.160	35.100	367	5451
3.64	1.39	2.200	4.870	5.310	3.870	1.980	38.100	360	5464
	1.39	2.410	5.110	5.240	3.870	1.980	38.100	360	5464
3.66	1.42	2.420	5.110	5.100	3.880	1.990	38.400	360	5462
	1.42	2.490	5.100	5.220	3.880	1.990	38.400	360	5462
3.77	1.40	2.380	5.010	5.260	3.910	1.860	38.120	365	5488
	1.40	2.440	5.240	5.240	3.910	1.860	38.120	365	5488
3.77	1.45	2.470	4.980	5.270	3.920	1.880	38.060	367	5485
	1.45	2.620	5.200	5.190	3.920	1.880	38.60	367	5485
3.77	1.53	2.570	5.180	5.210	3.900	1.970	38.80	375	5490
	1.53	2.630	5.360	5.240	3.900	1.970	38.80	375	5490
3.83	1.60	2.610	5.030	4.900	4.010	1.910	39.00	372	5497
	1.60	2.800	5.240	5.020	4.010	1.910	39.00	372	5497
3.84	1.51	2.530	4.980	4.810	3.920	1.930	38.90	380	5501
	1.51	2.670	5100	4.880	3.920	1.930	38.90	380	5501
3.86	1.49	2.310	4.730	4.930	3.900	1.910	38.70	380	5498
	1.49	2.480	4.950	4.980	3.900	1.910	38.70	380	5498
3.88	1.47	2.440	5.150	5.330	4.100	2.130	36.550	370	5499
	1.47	2.600	5.360	5.490	4.100	2.130	36.550	370	5499
3.91	1.50	2.560	5.050	5.240	3.900	2.230	37.990	372	5504
	1.50	2.700	5.250	5.330	3.900	2.230	37.990	372	5504
3.92	1.49	2.480	4.990	5.440	4.010	2.420	37.110	365	5515
	1.49	2.600	5.050	5.370	4.010	2.420	37.110	365	5515
3.92	1.51	2.520	5.080	5.260	4.110	2.130	37.820	365	5507
	1.51	2.600	5.220	5.290	4.110	2.130	37.820	365	5507
3.94	1.52	2.550	4.300	5.210	3.860	1930	37.940	355	5520
	1.52	2.540	4.520	5.170	3.860	1.930	37.940	355	5520
3.96	1.58	2.560	5.100	5.080	3.870	1.910	38.010	365	5516
	1.58	2.550	5.320	5.120	3.870	1.910	38.010	365	5516
3.97	1.54	2.490	4.990	4.910	3.810	1.920	38.100	365	5511
	1.54	2.680	5.170	4.980	3.810	1.920	38.100	365	5511
3.98	1.51	2.510	5.120	4.900	3.830	1.900	38.200	355	5524
	1.51	2.620	5.300	4.920	3.830	1.900	38.200	355	5524
4.00	1.54	2.590	5.190	5.060	3.820	1.930	38.110	365	5428
	1.54	2.720	5.370	5.040	3.820	1.930	38.110	365	5428
4.13	1.51	2.520	5.080	5.220	4.100	2.090	37.700	370	5398
	1.51	2.640	5.210	5.010	4.100	2.090	37.700	370	5398
4.14	1.47	2.470	4.490	5.130	3.880	1.930	37.960	365	5404
	1.47	2.500	4.610	5.210	3.880	1.930	37.960	365	5404
4.15	1.52	2.510	5.180	4.970	3.890	1.900	37.950	360	5407
	1.52	2.550	5.310	5.030	3.890	1.900	37.950	360	5407
4.16	1.53	2.540	5.200	4.880	3.790	1.810	38.300	365	5408
	1.53	2.750	5.430	4.920	3.790	1.810	38.300	365	5408
4.20	1.58	2.490	5.130	4.680	3.830	1.800	38.220	367	5413
	1.58	2.720	5.330	4.790	3.830	1.800	38.220	367	5413
4.21	1.56	2.530	5.180	4.990	3.780	1.880	38.100	367	5421
	1.56	2.650	5.220	5.050	3.780	1.880	38.100	367	5421
4.22	1.25	2.490	4.980	4.940	3.810	1.910	37.890	347	5419
	1.25	2.510	5.100	4.960	3.810	1.910	37.890	347	5419
4.22	1.57	2.540	5.270	4.890	3.840	1.950	38.240	370	5422
	1.57	2.600	5.400	4.910	3.840	1.950	38.240	370	5422
4.23	1.52	2.560	5.500	4.860	3.720	1.940	38.300	370	5425
	1.52	2.650	5.720	4.880	3.720	1.940	38.300	370	5425
4.24	1.53	2.510	5.370	5.010	4.110	1.970	37.400	372	5429
	1.53	2.600	5.500	5.090	4.110	1.970	37.400	372	5429

Continuation of the appendix

Skewness	Kawabata Eva.System			Concentrated Loading Method					
Cm	G	HG.5	HG5	EML	EHF	MG	PBS	Fw.gr	Art. no
4.30	1.54	2.490	5.220	5.100	4.120	1.910	37.550	370	5438
	1.54	2.530	5.180	5.110	4.120	1.910	37.550	370	5438
4.30	1.51	2.510	4.990	5.280	4.230	2.030	37.030	367	5445
	1.51	2.550	5.150	5.300	4.230	2.030	37.030	367	5445
4.32	1.53	2.520	5.100	5.110	4.130	1.940	37.440	362	5455
	1.53	2.610	4.980	5.190	4.130	1.940	37.440	362	5455
4.33	1.52	2.550	5.050	5.290	4.070	1.990	37.660	369	5378
	1.52	2.400	5.200	5.230	4.070	1.990	37.660	369	5378
4.33	1.53	2.560	5.120	5.060	4.080	2.020	37.960	365	5388
	1.53	2.610	5.060	5.110	4.080	2.020	37.960	365	5388
4.34	1.51	2.480	4.990	5.240	4.180	2.100	37.170	367	5457
	1.51	2.380	5.180	5.270	4.180	2.100	37.170	367	5457
4.37	1.57	2.440	5.200	5.380	3.900	2.230	37.910	362	5458
	1.57	2.340	5.410	5.330	3.900	2.230	37.910	362	5458
4.37	1.52	2.540	5.050	5.110	4.050	1.970	37.650	365	5465
	1.52	2.660	5.320	5.010	4.050	1.970	37.650	365	5465
4.40	1.56	2.510	5.100	4.970	3.780	1.870	38.120	365	5463
	1.56	2.700	5.420	4.970	3.780	1.870	38.120	365	5463
4.49	1.55	2.570	5.170	4.920	3.810	1.920	37.890	365	5473
	1.55	2.720	5.320	4.910	3.810	1.920	37.890	365	5473
4.50	1.56	2.520	5.060	4.810	3.710	1.930	38.340	372	5476
	1.56	2.750	5.300	4.830	3.710	1.930	38.340	372	5476
4.50	1.57	2.540	5.180	4.590	3.620	1.840	38.350	370	5481
	1.57	2.550	5.200	4.660	3.620	1.840	38.350	370	5481
4.51	1.62	2.550	5.200	4.710	3.610	1.810	38.400	355	5482
	1.62	2.490	5.320	4.680	3.610	1.810	38.400	355	5482
4.91	1.59	2.530	5.190	4.830	3.700	1.950	38.340	350	5420
	1.59	2.490	5.180	4.880	3.700	1.950	38.340	350	5420
4.93	1.56	2.540	5.210	4.900	3.780	1.870	38.100	365	5377
	1.56	2.600	5.400	4.930	3.780	1.870	38.100	365	5377
5.18	1.57	2.550	5.060	4.880	3.790	1.850	38.120	357	5474
	1.57	2.700	5.400	4.830	3.790	1.850	38.120	357	5474
5.20	1.64	2.580	5.300	4.770	3.700	1.850	38.330	360	5393
	1.64	2.720	5.510	4.710	3.700	1.850	38.330	360	5393
5.24	1.59	2.600	5.220	4.910	3.770	1.930	38.110	365	5472
	1.59	2.550	5.250	4.890	3.770	1.930	38.110	365	5472
5.28	1.55	2.550	5.270	4.690	3.600	1.900	38.320	360	5442
	1.55	2.600	5.300	4.660	3.600	1.900	38.320	360	5442
5.30	1.59	2.490	5.130	4.240	3.570	1.810	38.310	365	5373
	1.59	2.600	5.200	4.440	3.570	1.810	38.310	365	5373
5.32	1.60	2.700	5.500	4.400	3.610	1.790	38.400	357	5456
	1.60	2.900	5.550	4.330	3.610	1.790	38.400	357	5456
5.35	1.61	2.780	5.480	4.370	3.580	1.760	38.600	367	5409
	1.61	2.770	5.600	4.380	3.580	1.760	38.600	367	5409

G = Shear rigidity in (gf./cm deg)

HG.5 = Hysteresis of shear force at 0.5° shear angle in gf./cm

HG5 = Hysteresis of shear force at 5° shear angle in gf./cm

Fw.gr = Fabric length weight in grams

Art no. = Article number

EML = Strain at 200-gram load in percentage

EHF = Strain at 150-gram load in percentage

MG = Maximum distance (strain) between loading-unloading curves in percentage

PBS = Slope at critical point in gram force