



**International Institute for Cotton  
Technical Research Division  
Manchester**

**Research Record No. 84**

**Investigation Into Obtaining The Fully Relaxed State  
Of Knitted Fabric By Evaluation Of  
Shrinkage And Spirality.**

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**Key Words:** 28g Single Jersey, 1x1 Rib, Shrinkage, Spirality

**Digital Version:** April 2009  
spreadsheet is *RR84.xls* diagrams are in *RR84.ppt*



## Introduction

Due to the large amount of samples to be tested for the Central Project, it was decided to try and cut down the amount of time involved in reaching the fully relaxed state of the sample.

From talks with Meridian it was suggested that just soaking the sample, followed by tumble drying, was adequate in reaching full relaxation. Therefore, as the method of drying has previously been found to be more important than the actual washing, it was decided to compare a soak-and-tumble procedure with our normal machine-wash-and-tumble cycles.

A small trial was carried out on 1x1 rib followed by a larger investigation on 28 gauge single jersey fabric.

## Evaluation

Samples of a greige state (yarn dyed) 1x1 rib were subjected to one of two relaxation procedures as follows.

- a) 5 cycles: machine wash and tumble dry (W&TD)  
50°C wash, 80 min tumble dry.
- b) 5 cycles: soak/spin and tumble dry (S&TD)  
5 min cold water soak in 1 g/l Lissapol NX, 4 min spin, 80 min tumble dry.

The results showed very small differences between the two methods (*Table 1*)

**Table 1: Preliminary Evaluation**

	5 W&TD		5 S&TD	
	Mean	C.L.	Mean	C.L.
Length Shrinkage, %	16.73	0.23	17.68	1.56
Width Shrinkage, %	6.74	1.70	7.39	1.73
Spirality	0.84	0.24	1.01	0.39
Courses /3cm	45.8	0.12	45.6	1.13
Wales /3cm	28.4	0.14	27.7	0.13

The time taken for the soak and tumble cycles was approximately half that of the machine wash.

To confirm these findings it was decided to carry out a larger trial on a set of 28 gauge single jersey fabrics of varying constructions. The constructions of these fabrics are shown below in *Table 2*.

**Table 2: Constructions Of The Test Fabrics**

Yarn Count	Stitch Length, mm				
	Ne				
28	4.3	3.9	3.5	3.1	2.7
30	4.5	4.0	3.5	3.0	2.6
34	4.7	4.2	3.7	3.1	2.6
38	4.7	4.2	3.7	3.1	2.6
40	4.7	4.2	3.7	3.1	2.6

Because the twenty five fabrics were in their grey state, it was thought necessary to revise the five soak/tumble cycles to one machine wash and tumble followed by four soak and tumble cycles. This first wash was decided to be enough to remove any natural waxes off the fabric.

The machine wash and tumble method became IIC Test Method No. KT1A and the soak and tumble method became Test Method No. KT1B (see attached methods). Spirality measurements were also taken after each method.

## Results

Results of the trial are shown in *Table 3* and *Figures 1 & 2*.

There appears to be very good correlation between the two methods, both in shrinkage values and spirality angles.

The best straight lines (with zero intercept) and the standard deviations of the differences were calculated. The results are given below and are shown in *Figures 3, 4 & 5*.

	Length Shrinkage	Width Shrinkage	Spirality
	%	%	deg
Mean KT1A	29.39	-6.35	38.97
Mean KT1B	28.68	-6.6	38.18
Mean difference	-0.71	-0.25	-0.79
S.D. of Differences	1.50	3.33	1.36
Regression slope	0.9796	1.0008	0.9805
Regression R <sup>2</sup>	0.9746	0.9727	0.987

It is clear that there is no significant difference between the two methods.

## **Conclusions**

The results of this investigation show that there is very little difference in the test results returned by the two methods.

The results of the initial trial, on 1x1 rib, indicated that in using Method KT1B, the testing time was virtually halved. However, on a larger number of samples, Method KT1B was using operator time to soak the samples, therefore having no advantage over Method KT1A. As time was the prime factor in this trial, it was decided to replace the four soaks by four rinse cycles in the washing machine which cuts down the time and does not require constant operator attention.

This third method will be recorded in the *IIC Methods of Test* under KT1C.

**Table 3: Comparison Of Relaxation Procedures KT1A And KT1B**

Sample	Length Shrinkage %				Width Shrinkage % *				Relaxed Spirality			
	KT1A	C.L.	KT1B	C.L.	KT1A	C.L.	KT1B	C.L.	KT1A	C.L.	KT1B	C.L.
<b>SJ28/430</b>	40.30	2.83	38.22	6.54	-26.76	3.03	-23.87	9.91	46.08	1.12	45.57	1.15
<b>SJ28/390</b>	36.04	1.68	34.58	2.01	-12.48	1.78	-11.40	4.08	42.34	1.00	42.25	1.10
<b>SJ28/350</b>	30.10	1.43	29.52	1.20	0.25	1.06	0.85	1.92	33.90	0.80	34.13	0.92
<b>SJ28/310</b>	23.33	1.19	21.57	0.89	8.66	0.55	9.64	0.70	25.40	0.78	25.34	0.84
<b>SJ28/270</b>	13.58	1.19	12.67	0.93	16.24	2.32	10.09	1.89	17.08	0.62	16.60	0.96
<b>SJ30/450</b>	38.55	2.74	37.55	5.35	-29.37	2.82	-35.74	10.43	49.06	1.13	50.47	1.25
<b>SJ30/400</b>	36.31	2.17	36.66	3.37	-16.35	1.22	-21.25	4.48	43.76	0.92	42.53	1.56
<b>SJ30/350</b>	29.65	1.12	30.65	0.85	-2.24	1.74	-2.39	1.63	39.66	1.23	36.57	1.72
<b>SJ30/300</b>	24.90	2.70	21.86	3.83	9.95	1.35	10.71	1.30	27.04	0.98	27.08	1.03
<b>SJ30/260</b>	12.42	1.14	10.67	1.18	19.98	0.28	19.70	0.30	17.18	0.77	17.65	0.69
<b>SJ34/470</b>	34.44	2.92	33.14	4.43	-30.58	5.07	-33.45	10.19	55.06	1.13	50.27	1.78
<b>SJ34/420</b>	35.01	2.22	36.52	1.79	-21.00	5.07	-20.33	4.43	47.04	1.04	46.87	1.08
<b>SJ34/370</b>	33.23	3.06	30.86	2.03	-6.72	4.50	-5.10	1.37	42.16	1.08	39.67	1.20
<b>S34/310</b>	24.49	0.70	25.51	1.33	9.16	0.90	8.81	1.14	32.24	1.02	29.44	0.96
<b>SJ34/260</b>	14.46	0.36	12.94	0.84	19.13	0.59	19.87	0.84	21.50	0.81	19.63	0.77
<b>SJ38/470</b>	38.46	2.55	36.16	3.84	-32.83	6.17	-33.37	8.14	54.02	1.75	54.97	1.20
<b>SJ38/420</b>	40.68	3.78	40.83	4.67	-30.32	5.36	-28.17	9.79	52.66	1.20	52.47	1.04
<b>SJ38/370</b>	34.18	3.19	35.32	2.56	-7.88	3.52	-9.05	4.59	43.46	1.10	43.17	1.14
<b>SJ38/310</b>	25.58	1.84	23.97	1.34	8.18	2.26	8.87	1.60	37.26	1.11	36.49	1.06
<b>SJ38/260</b>	14.67	0.42	14.06	1.14	19.97	1.02	20.78	0.61	26.94	0.99	26.13	1.12
<b>SJ40/470</b>	40.03	7.71	36.70	3.12	-45.65	14.14	-37.51	11.63	56.00	2.03	54.58	1.22
<b>SJ40/420</b>	39.52	2.03	42.01	4.98	-27.56	3.85	-35.60	10.78	52.52	1.41	51.68	1.22
<b>SJ40/370</b>	33.62	1.89	33.69	2.19	-8.96	3.51	-7.61	4.57	46.32	1.17	46.04	1.04
<b>SJ40/310</b>	24.61	2.14	25.53	1.45	8.35	3.33	9.56	1.97	37.82	0.88	37.79	1.15
<b>SJ40/260</b>	16.62	1.27	15.89	1.21	20.06	0.87	20.87	0.84	27.66	0.97	27.13	0.89
<b>Mean</b>	<b>29.39</b>	<b>2.17</b>	<b>28.68</b>	<b>2.52</b>	<b>-6.35</b>	<b>3.05</b>	<b>-6.60</b>	<b>4.37</b>	<b>38.97</b>	<b>1.08</b>	<b>38.18</b>	<b>1.12</b>

\* Negative values indicate an extension

Figure 1: Shrinkages

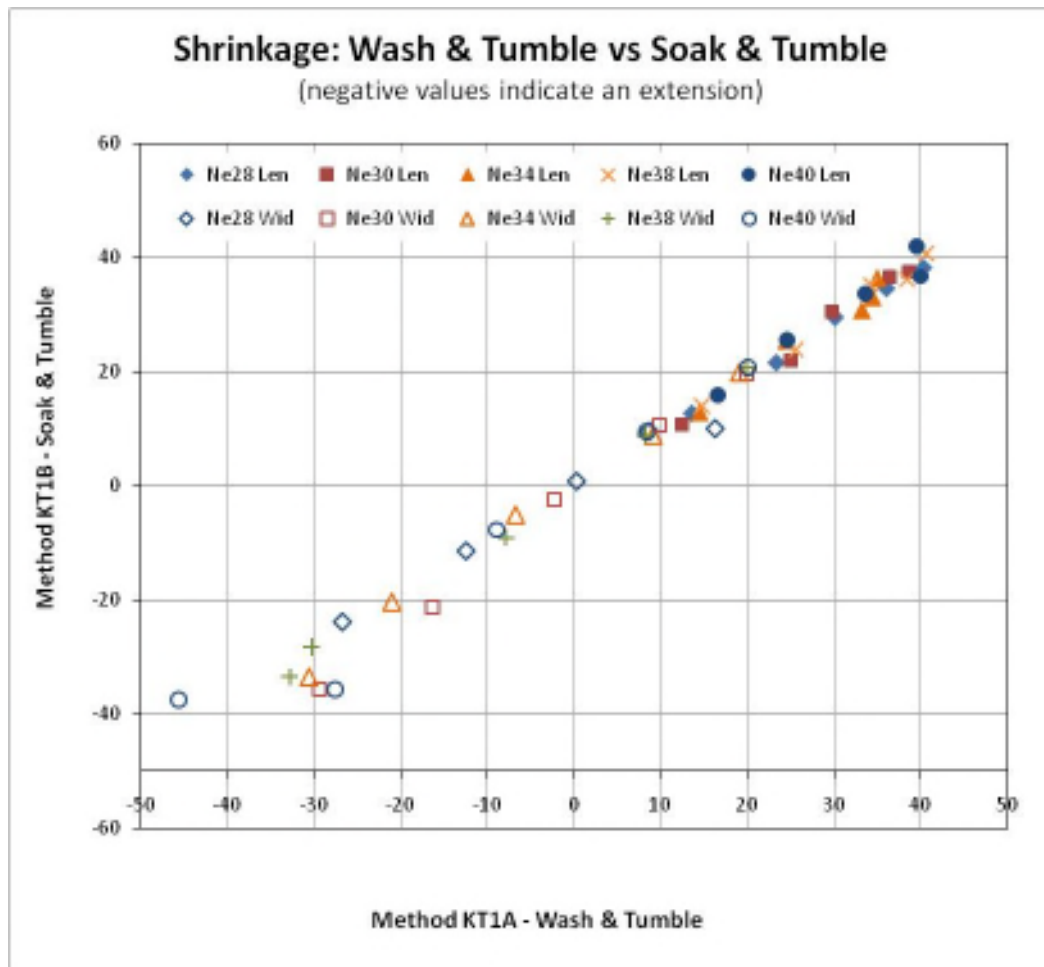


Figure 2: Spirality

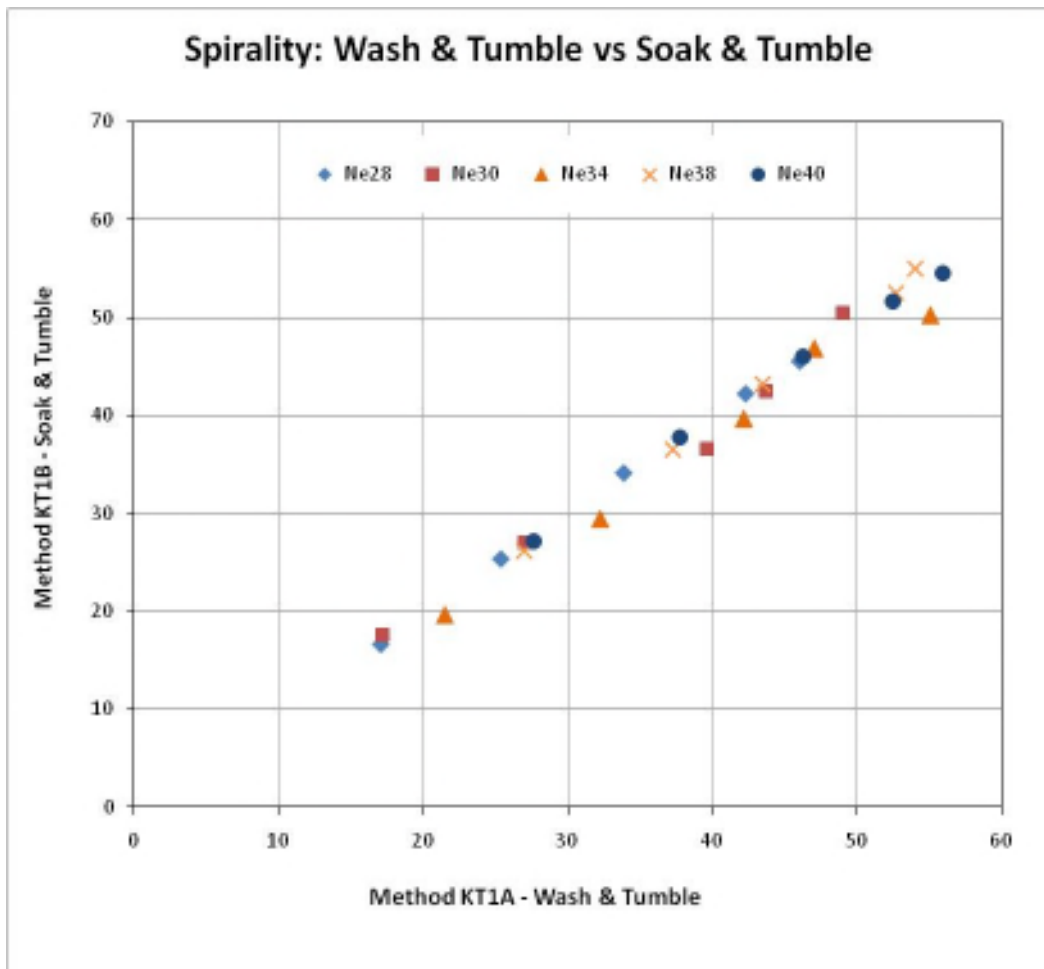




Figure 3: Length Shrinkage - Regression

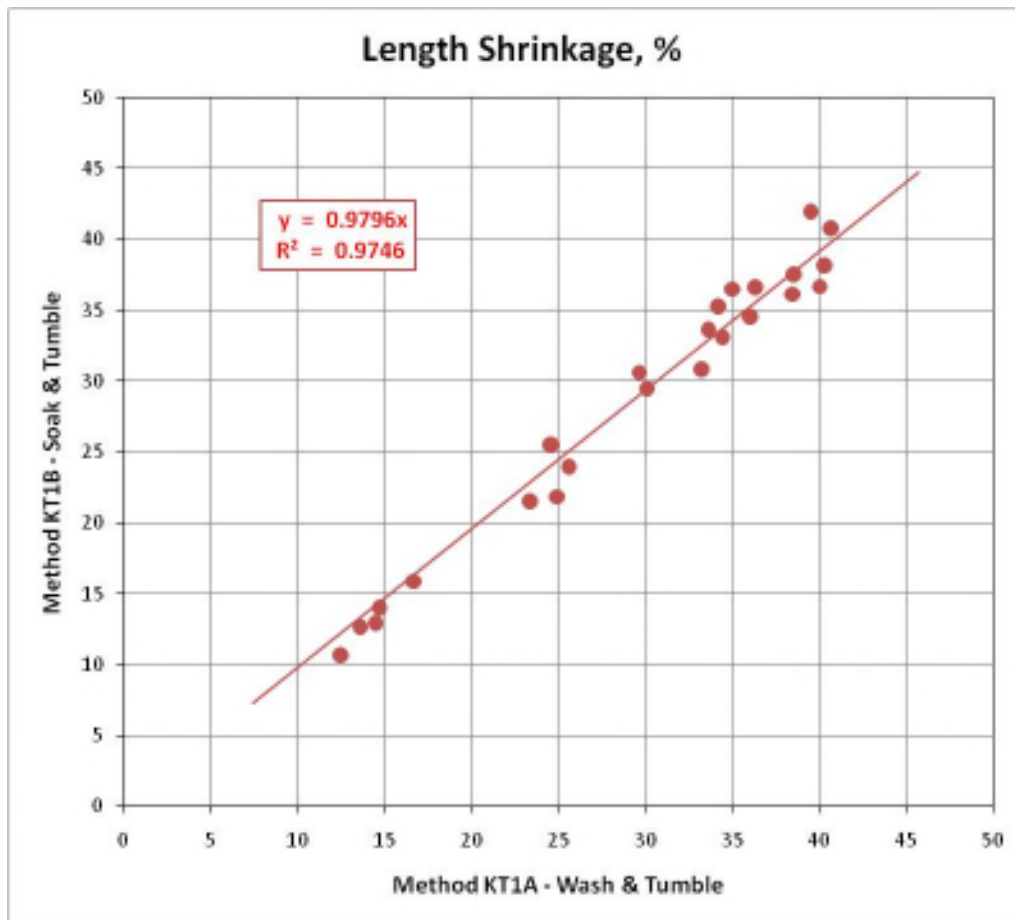


Figure 4: Width Shrinkage - Regression

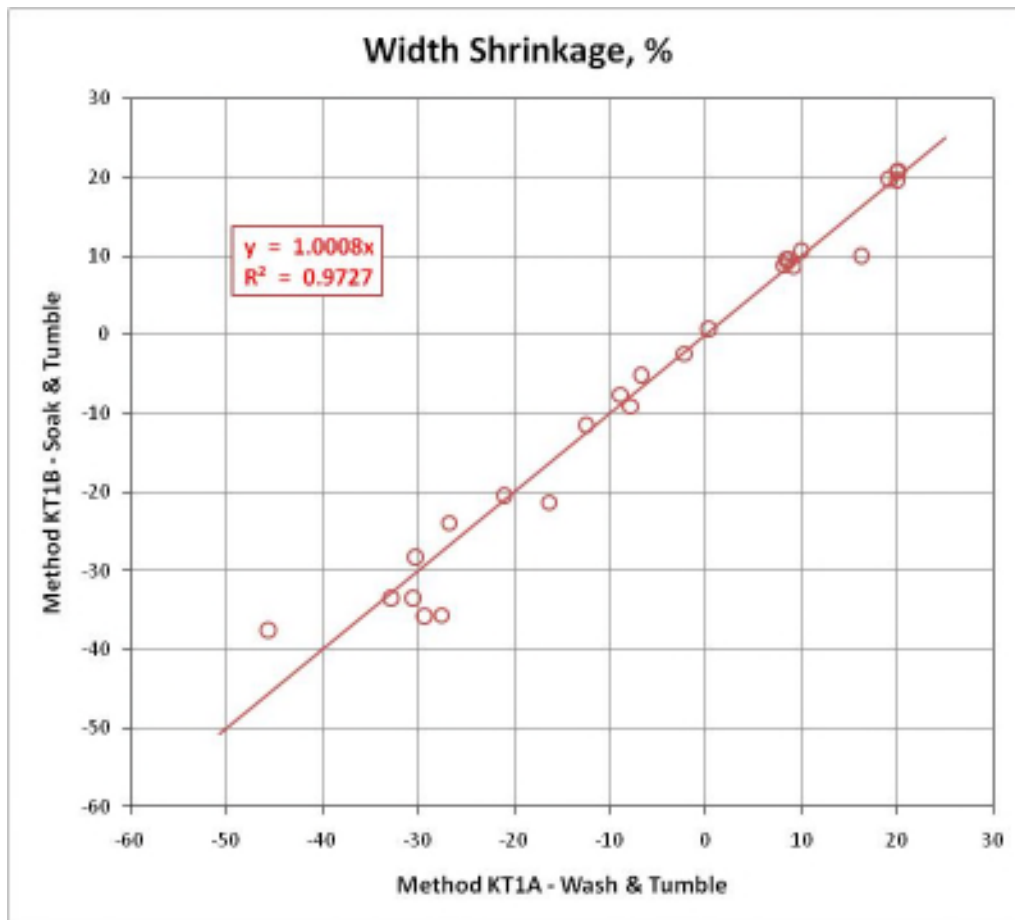
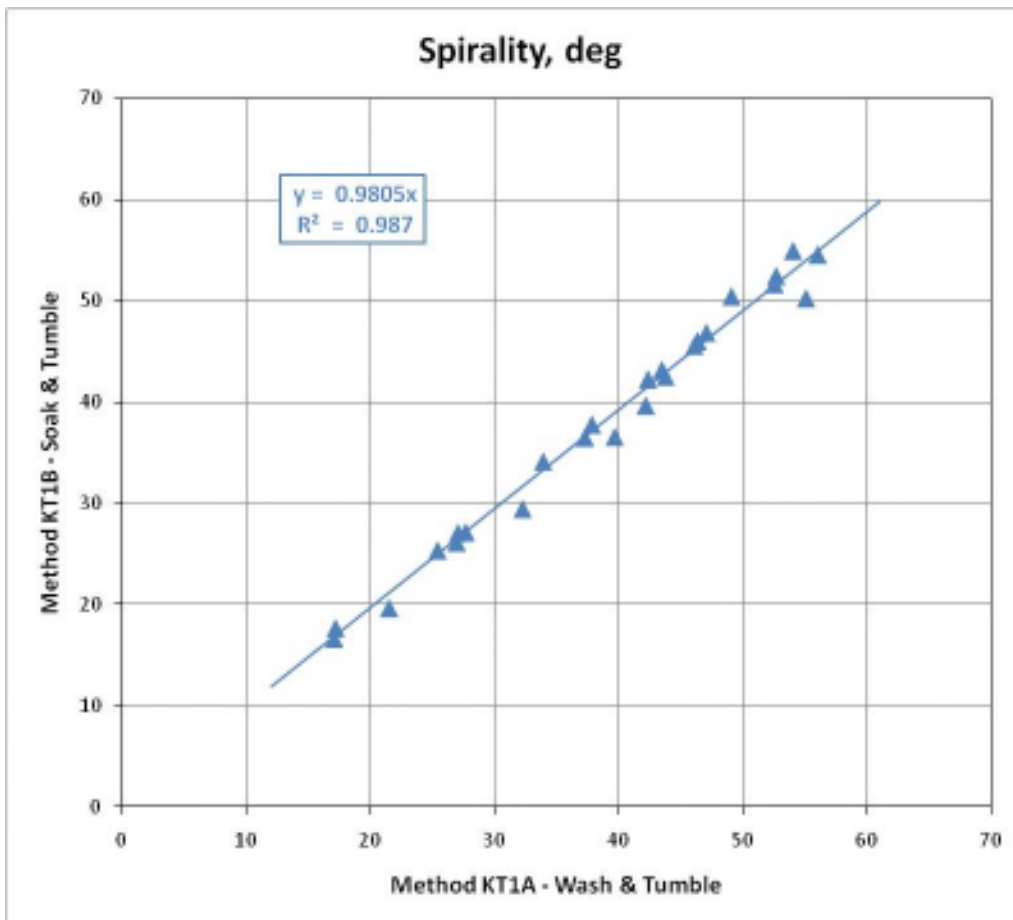


Figure 5: Spirality - Regression



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## Method Of Test

### KT1A

#### Determination Of The Dimensional Changes Induced In Cotton Weft Knitted Fabrics By A Specified Relaxation Procedure.

May 1978

### Principle

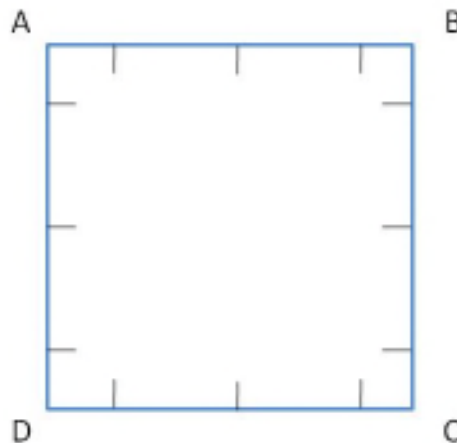
A fabric is subjected to a specified procedure and dried under the appropriate conditions, and any changes in dimensions are determined.

Method 1: By washing in a domestic automatic washing machine and tumble drying.

### Apparatus

1. Hoover automatic De-Luxe washing machine.
2. Hoover tumble dryer
3. Two Perspex templates a) 25 x 25 cm and b) 50 x 50 cm, both having equidistantly located measuring marks on all sides (*Figure 1*).

**Figure 1**



Markings on AD are opposite those on BC (width measurement) and the markings on AB are opposite those on DC (length measurement).

4. Ruler and indelible pen.
5. A domestic automatic washing powder.
6. Means for providing the standard atmosphere for testing textiles specified in B.S. 1051, namely  $65 \pm 2\%$  RH and  $20 \pm 2^\circ\text{C}$ .

## Test Procedure

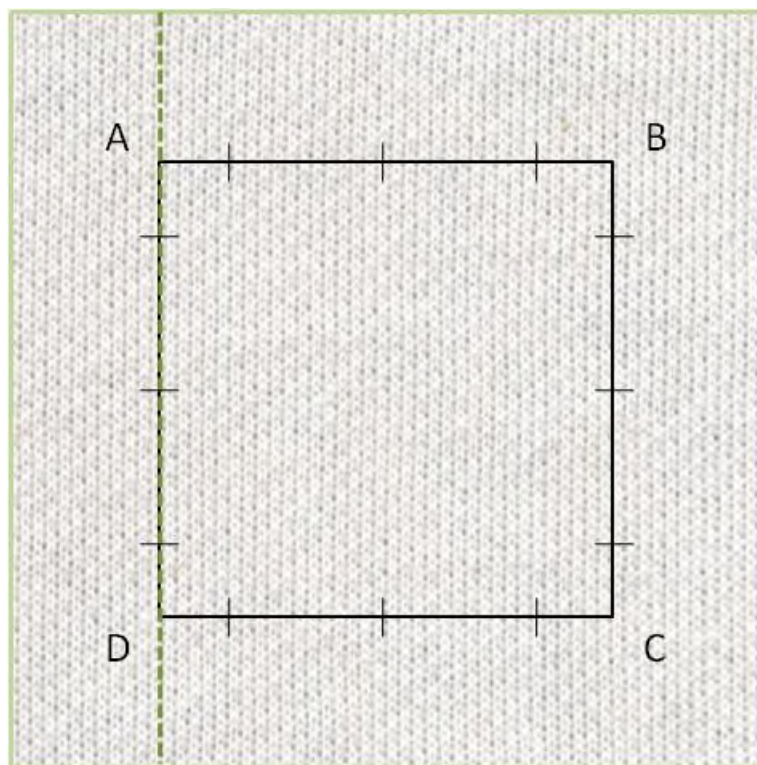
### Conditioning

Samples are allowed to condition until they have reached equilibrium in the standard atmosphere for testing textiles (minimum 4 hours).

### Specimen Preparation

1. The sample is laid on a flat surface removing wrinkles without stretching.
2. Five test specimens are prepared for each conditioned fabric sample, a minimum of 20cm larger in both directions than the required size of template, e.g. the 25 x 25 cm template requires a specimen of at least 45 x 45 cm.
3. The required size of template is placed centrally on the specimen so that one edge follows a wale line.
4. The test area is defined by drawing round the template. The three measuring marks are then drawn on each side of the square ABCD (*Figure 2*).

**Figure 2**



5. The distances between the marks are measured and recorded.

### Laundering

1. Recommended loading for absorbent materials in a Hoover De-Luxe washing machine is 2.75 kilos (6 lb).
2. The specimens are weighed and placed in the machine. (Where necessary, the load is made up to 6 lb).

3. The prescribed amount of washing powder is placed in the dispenser and the machine set to wash at 60°C with a long spin.
4. On completion of the wash cycle, the load is tumble dried at the highest temperature setting, establishing the required drying time.
5. The laundering and tumble drying is repeated a further four times, making a total of five cycles.
6. After the fifth tumble drying cycle the test specimens are conditioned before measuring.

### **Measurement**

1. The specimens are laid on a flat surface, removing wrinkles without stretching.
2. The distances between the pairs of marks are measured and recorded.

### **Calculation Of Results**

The mean changes in dimensions in both length and width directions are calculated and expressed as percentages of the original mean length and width respectively. The 95% Confidence Limits and the % Accuracy are also calculated.

An extension is indicated by the prefix Ext.

### **REFERENCES**

Research Record No. 59  
B.S. 1051

# International Institute For Cotton

## Method Of Test

### KT1B

#### Determination Of The Dimensional Changes Induced In Cotton Weft Knitted Fabrics By A Specified Relaxation Procedure.

May 1978

### Principle

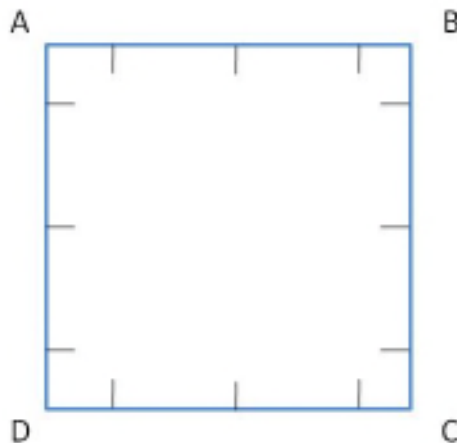
A fabric is subjected to a specified procedure and dried under the appropriate conditions, and any changes in dimensions are determined.

Method 2: By washing and tumble drying followed by soaking and tumble drying.

### Apparatus

1. Hoover automatic De-Luxe washing machine.
2. Hoover tumble dryer.
3. Two Perspex templates a) 25 x 25 cm and b) 50 x 50 cm, both having equidistantly located measuring marks on all sides (*Figure 1*).

**Figure 1**



NB: Markings on AD are opposite those on BC (width measurement) and the markings on AB are opposite those on DC (length measurement).

4. Ruler and indelible pen.
5. A domestic automatic washing powder.
6. Lissapol NX or equivalent wetting agent.
7. Means for providing the standard atmosphere for testing textiles specified in B.S. 1051, namely  $65 \pm 2\%$  RH and  $20 \pm 2^\circ\text{C}$ .

## Test Procedure

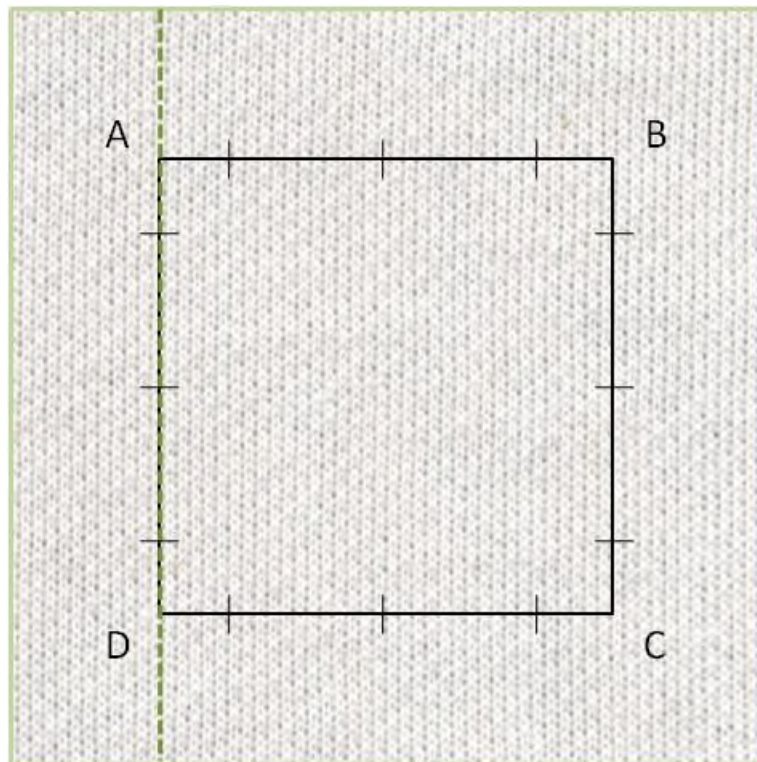
### Conditioning

Samples are allowed to condition until they have reached equilibrium in the standard atmosphere for testing textiles (minimum 4 hours).

### Specimen Preparation

1. The sample is laid on a flat surface removing wrinkles without stretching.
2. Five test specimens are prepared for each conditioned fabric sample, a minimum of 20cm larger in both directions than the required size of template, e.g. the 25 x 25 cm template requires a specimen of at least 45 x 45 cm.
3. The required size of template is placed centrally on the specimen so that one edge follows a wale line.
4. The test area is defined by drawing round the template. The three measuring marks are then drawn on each side of the square ABCD (*Figure 2*).

**Figure 2**



### Laundering

1. Recommended loading for absorbent materials in a Hoover De-Luxe washing machine is 2.75 kilos (6 lb).



2. The specimens are weighed and placed in the machine. Where necessary, the load is made up to 6 lb.
3. The prescribed amount of washing powder is placed in the dispenser and the machine set to wash at 60°C with a long spin.
4. On completion of the wash cycle, the load is tumble dried at the highest temperature setting, establishing the required drying time.
5. After the first wash-and-tumble-dry cycle has been completed, the specimens are soaked in cold water with a few drops of Lissapol NX for 10 min, hydroextracted and then tumble dried for the same time as was established in 4.
6. The soaking and tumble drying is repeated a further three times, making a total of five cycles.
7. After the fifth tumble drying cycle the test specimens are conditioned before measuring.

## **Measurement**

The specimens are laid on a flat surface, removing wrinkles without stretching.

The distances between the pairs of marks are measured and recorded.

## **Calculation Of Results**

The mean changes in dimensions in both length and width directions are calculated and expressed as percentages of the original mean length and width respectively. The 95% Confidence Limits and the % Accuracy are also calculated.

An extension is indicated by the prefix Ext.

## **References**

B.S. 1051

# International Institute For Cotton

## Method Of Test

### KT2

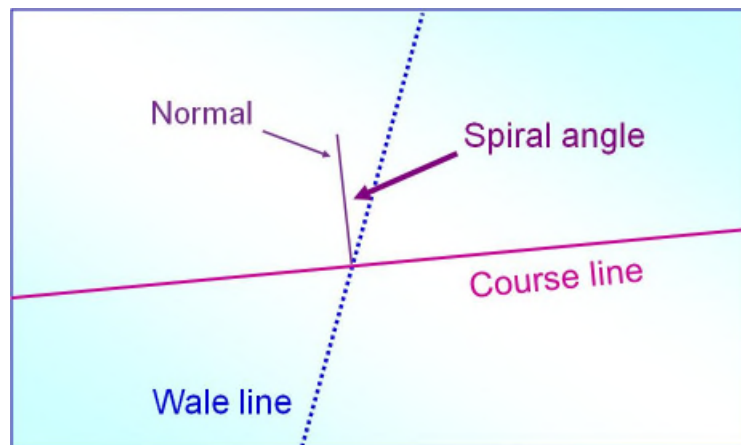
#### Determination Of The Angle Of Spirality in Weft Knitted Fabrics.

May 1978

### Definition

The angle of spirality is defined, for the purposes of this test, as the angle by which the line of wales deviates from the normal to the line of courses (*Figure 1*).

**Figure 1**



### Principle

The angle and direction of spirality is measured before and after a specified relaxation process and the change calculated.

### Apparatus

1. Large protractor
2. Means for providing the standard atmosphere for testing textiles specified in B.S. 1051, namely  $65 \pm 2\%$  RH and  $20 \pm 2^\circ\text{C}$ .

### Test Procedure

1. Samples are allowed to condition until they have reached equilibrium in the standard atmosphere for testing textiles (minimum 4 hours).
2. Spirality measurements are taken on the five test specimens prepared for relaxation testing.

3. Five measurements are taken at random on each of the five test specimens giving a total of 25 readings per sample.
4. The base line of the protractor is placed along a course line, ensuring that a wale line (x) intersects with the bottom of the 90° line on the protractor (*Figure 1*).

*Note for digital version: To aid correct location of the protractor, it is advantageous to mark a course line carefully with a fine felt-tip pen whilst viewing the course line under a pick-counting glass. Often it will be helpful to mark a wale line also.*

5. The angle between the wale line (x) and the perpendicular to the courses is measured and recorded, and also the direction of spiral.
6. After the specimens have been relaxed according to the specified method the measurements are repeated and the values recorded.
7. For double-jersey fabrics, where the line of courses is difficult to determine by eye, a few courses may be unravelled to establish the exact line of the courses before measurements are taken.

### **Calculation Of Results**

The mean, 95% Confidence Limits and % Accuracy are calculated from the 25 readings taken before relaxation and from the 25 readings taken after relaxation.

The change in the angle can be calculated if required by deducting the mean of the before-relaxation readings from the mean of the after-relaxation readings.

Note: This test is always carried out in conjunction with the specified relaxation test.