# SAWTRI TECHNICAL REPORT

## No. 247

# Some Double Jersey Tuck Structures in Wool

## Part I: Knitting Performance and Dimensional Properties

by

L. Hunter

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR

P. O. BOX 1124
PORT ELIZABETH
REPUBLIC OF SOUTH AFRICA

ISBN 0 7988 0586 2

# SOME DOUBLE JERSEY TUCK STRUCTURES IN WOOL – PART I KNITTING PERFORMANCE AND DIMENSIONAL PROPERTIES

*by L. HUNTER*

## ABSTRACT

*The dimensional properties and knitting performance of four double jersey tuck structures, viz. Single Piqué, Royal Interlock, Pin-tuck and Texipiqué, have been investigated. The structures were knitted on an 18 gauge machine from a shrinkresist treated wool worsted yarn employing different SCSL's and run-in-ratios. The dimensional constants (K-values) were in general dependent upon the run-in-ratio even after the fabrics had been subjected to a 15 minute dynamic relaxation test and a three hour wash test in a Cubex washing machine. Most yarn breakages occurred at the interlock feeders and it appeared that a high run-in at the interlock feeders and an intermediate run-in at the tuck feeders gave the best knitting performance.*

## KEY WORDS

Tuck structure – dimensional constants – relaxation shrinkage – Single Piqué – Royal Interlock – Pin-tuck – Texipiqué – K-values – knitting performance.

## INTRODUCTION

Ever since the pioneering work of Doyle[1] and Munden[2], relating the number of courses and wales per unit length and their product (and therefore the fabric dimensions) to stitch length for plain (single) jersey structures various attempts have been made to extend the work to cover more complex structures and also to achieve a truly minimum energy fabric state for which the various dimensional constants in fact would be constant and independent of yarn, fabric and machine variables. Thus, for instance, the dimensional properties of the 1 x 1 rib structure were investigated by several authors [3–8] and those of more complex structures such as Punto-di-Roma[9, 10, 11], Swiss[10, 13] and French Double Piqué[12, 13], Interlock[13], Eightlock[14] and Half Cardigan[7] were also investigated. In most of these complex structures the dimensional constants (K values) were found to vary, apparently according to the state of relaxation of the fabric and various states, have been characterised e.g. dry-relaxed, wet-relaxed, fully-relaxed, completely-relaxed, etc. Although the various dimensional constants tended to become independent of most structural, yarn and machine variables as the fabric approached its supposedly minimum energy state, some parameters, such as run-in-ratio, have been found to affect the dimensional constants significantly [10, 11]. This implies that the dimensions of a complex structure, involving different loop types, are not solely dependent upon the length of yarn in a unit cell (SCSL) but at least depend upon one other variable, namely run-in-ratio.

Some reference [15] has also been made to structures involving tuck loops in addition to the Half-Cardigan structure referred to earlier. Nevertheless, no systematic study covering a wide range of run-ins has as yet been undertaken on such structures.

In the present investigation certain dimensional and other properties of four double jersey tuck structures (Single Piqué, Royal Interlock, Pin-Tuck and Texipiqué) in wool have been studied. The aim of this part of the study was to investigate the knitting performance and dimensional properties of these fabrics at different SCSL's and run-in-ratios so as to establish the effect of the latter two parameters on knitting performance, fabric appearance, the various dimensional constants and fabric shrinkage during washing. The effect of these two parameters on the mechanical properties of the various fabrics will be reported on in Part II of this series.

## EXPERIMENTAL

### MATERIALS USED

A 64's quality merino wool was processed into tops and these were then shrinkresist treated according to the SAWTRI chlorine-aminoplast resin process [16, 17].

The fibre diameter of the wool at the top stage was 21,7 μm (CV=23,1 *per cent*) and the mean fibre length was 60,8 mm (CV=47,5 *per cent*). The tops were processed into 27,5 tex singles yarn with a twist of 524 t.p.m. and which had a breaking strength of 163 gf, an extension of 9,4 *per cent*, and an irregularity (CV) of 18,7 *per cent*.

### KNITTING DETAILS

The yarn was waxed and then knitted on a 30" diameter 18 gauge Wildt Mellor Bromley 8RD (1704 x 1704 needles) double jersey machine at a speed of 16,3 r/min and with the input tension maintained at 3 gf except in three cases where the positive feed wheels and cam settings did not permit this. In these cases the input tension was 4,5 gf. The fabric take-down tension was adjusted to as low a level as possible. Six needles delayed timing, a dial height of 1,2 mm and interlock gating were used. In the majority of cases about 500 machine revolutions were knitted per run-in and the number of holes in the fabric was noted. Table I gives the details of the run-ins employed for the various structures as well as the number of holes per 500 machine revolutions. In most cases the range of fabrics which could be knitted was limited by the cam settings although, in the case of the Texi-piqué structure, problems were encountered with the knitting thereof due to the needles on both needle beds being required to tuck at the same feeder. It is possible that the machine used was not entirely suitable for this particular structure. It appears, however, that this structure is seldom knitted in wool in the industry and it is therefore of limited interest. The four structures knitted are shown schematically in Fig 1, the terminology and scheme being those employed in the ISO Second Draft Proposal for Knitting Descriptions[18].

## RELAXATION PROCEDURES

### Dry-Relaxation

The fabrics were removed from the machine, allowed to relax in a standard atmosphere on wire mesh for 72 hours and the dimensions then measured in the same standard atmosphere. The values so obtained were termed the dry-relaxed values.

### Severe Dynamic Relaxation Test

After dry-relaxation the fabrics were subjected to the I.W.S. severe dynamic relaxation test for double jersey structures (TM186) involving 15 minutes agitation in a Cubex at 40°C (15 litres of pH 7 phosphate buffer solution plus 0,5 *per cent* nonionic detergent) after which they were conditioned and measured.

### Wash Test

The wash test involved a 3 hour wash in a Cubex and was based on the I.W.S. Test Method 185 (15 litres of pH7 buffer solution), except that the washing temperature was 60°C. A few samples were also washed at 40°C for purposes of comparison (see Table II).

The results in Table II indicate that the shrinkage values obtained at the two different temperatures were similar and on average differed only by two *per cent* (absolute). The conclusions drawn, trends observed and values arrived at, under

## RESULTS AND DISCUSSION

As far as the knitting performance of the various structures is concerned, it was observed that most of the yarn breakages (holes) occurred at the interlock feeders. This is probably due to the fact that the interlock loops had to be held for one or more knitting cycles (feeders) as the tuck loops were being formed and the tension in them, particularly during knock-over, would therefore be rather high causing yarn breakages (i.e. holes). No consistent trend in the number of holes can be observed in Table I for the different structures although a high run-in at the interlock feeders and an intermediate run-in at the tuck feeders generally appear preferable. Nevertheless, this would probably not give the best dimensional stability neither would it give the desired appearance in the case of the Single Piqué structure. In practice a compromise would, therefore, have to be made.

Regression analyses were carried out on the various dimensional constants and shrinkage values on the one hand and SCSL and run-in-ratio, respectively, on the other hand for the various states of relaxation of the fabrics (see Table III). The main aim was to ascertain whether the dimensional constants (K1 to K4) were independent of SCSL and run-in-ratio since, if this were the case, only one value for each of K1 to K4 would suffice to determine uniquely the dimensions of the fabric in a certain state of relaxation. The dimensions are only really defined when the fabric is in a minimum energy state, provided, of course, such a unique state exists.

The average K-values and shrinkages obtained at the various stages are given in Tables IV to VII. The average open width of the different structures in the various states of relaxation is also shown in these tables. From these tables a number of interesting points emerge. Except for the Texipiqué structure (the results of which are regarded as tentative only) the *length* shrinkage was always much *higher* than the width shrinkage suggesting that, during knitting, length distortion was much greater than width distortion. If this distortion could be reduced, fabric shrinkage would be decreased considerably. Furthermore, from Tables IV to VII it is apparent that most of the shrinkage, in both length and width, occurred during the 15 minute severe dynamic relaxation test. Very little shrinkage (i.e. the difference between the third and fourth columns which was of the order of three *per cent* in the length direction) occurred during the three hour wash test. This, together with the fact that very little shrinkage (on average less than one *per cent*) occurred in the width direction during the three hour wash test indicate that this was still residual relaxation shrinkage and not felting shrinkage. Visual examination of the fabrics revealed no sign of surface felting. It is, therefore, concluded that the total shrinkage given in the last columns of Tables IV to VII is a measure of the total relaxation shrinkage of the fabrics and that, after the completed wash test, the fabrics were probably close to or in a relaxed or minimum energy state.

From results of the regression analyses tabulated in Table III, it is apparent that, in the majority of cases, a significant correlation exists between the K-values (particularly K1 and K2 and often also K3 and K4) and run-in-ratio. In many cases the K-values are also correlated with the SCSL. This implies that, for these structures, the dimensional constants (K-values) are not truly constant, but are highly dependent upon the run-in-ratio at least. This confirms the results obtained by other workers on other complex double jersey structures and means that to predict the dimensions of these tuck structures both the SCSL and run-in-ratio have to be taken into consideration. The dependence of the K-values on run-in-ratio still exists even after the wash test which implies that even in their "fully relaxed" state the fabric dimensions are not uniquely determined by the SCSL but also depend upon the run-in-ratio. Some of the trends exemplified by the correlation coefficients and discussed above are illustrated for the Single Piqué and Royal Interlock structures, in Figures 2 to 8. These figures show that the dependence of the K-values on run-in-ratio is certainly not reduced as the fabric tends towards and reaches (by assumption) its fully relaxed state.

Most of the fabrics came off the machine very wide (see Tables IV to VII) and tended to be heavy which is what could be expected of a structure involving a tuck loop. The Single Piqué structure had a characteristic and attractive appearance (honey comb or piqué — see sample in Appendix) different from that of other double jersey structures. This characteristic appearance became more pronounced as the run-in-ratio (i.e. ratio of interlock feed run-in to tuck feed (run-in) decreased and in particular when it decreased to below one. This characteristic appearance and "crisp" handle of the Single Piqué fabrics appeared to be adversely affected by the relaxation and washing tests. The Pin-tuck structure became unbalanced (i.e. tended to roll at the top and bottom edges) as the run-in at the tuck feeder increased and exceeded that at the interlock feeder. The Royal Interlock fabric had an appearance similar to that associated with an Eightlock structure.

## SUMMARY AND CONCLUSIONS

The knitting performance and dimensional constants of four double jersey tuck structures, viz. Single Piqué, Royal Interlock, Pin-tuck and Texipiqué, have been studied. The fabrics were knitted with different SCSL's and run-in ratios from a shrinkresist treated 27,5 tex wool worsted yarn and their dimensions were determined after dry-relaxation, severe dynamic relaxation and a three hour Cubex wash test.

Large shrinkages in length occurred during the dynamic relaxation test and only a small amount of shrinkage (of the order of three *per cent*, mainly in the length direction) occurred during the three hour Cubex wash test. This together with the fact that the fabrics showed no signs of surface felting, led to the conclusion that little, if any, felting shrinkage occurred and that the shrinkages which occurred subsequent to the relaxation test (i.e. during the three hour Cubex wash test) were residual relaxation shrinkage. It was, therefore, assumed that at the end of the wash test the fabrics were close to or in a state of minimum energy (i.e. fully relaxed). Nevertheless, even in this state the dimensional constants, and therefore the fabric dimensions, were dependent upon the run-in-ratio and in some cases the SCSL. The dimensional constants alone (K-values) cannot therefore be used to predict the fabric dimensions in a relaxed state — run-in-ratio has to be taken into consideration as well.

The characteristic appearance of the Single Piqué structure was found to depend upon the run-in-ratio, becoming more marked as the run-in-ratio (interlock to tuck feeder) decreased to values below one. At these run-in-ratios, however, the Pin-tuck structure became unbalanced and showed a tendency to roll at its ends.

Most yarn breakages occurred at the interlock feeders, probably during knock-over of the held loops, and it appeared that a high run-in at the interlock feeders and an intermediate run-in at the tuck feeders gave perhaps the best knitting performance.


## ACKNOWLEDGEMENTS

The author is indebted to Dr. D.P. Veldsman for initiating the project, Messrs. D.A. Dobson and M. Cawood for knitting the samples and for carrying out some of the measurements, Miss P. Schouten for carrying out the wash and dimensional tests and Mr. E. Gee and Miss Y. Mannell for the statistical analyses of the data. Permission by the S.A. Wool Board to publish these results is also gratefully acknowledged.


## REFERENCES


1. Doyle, P.J., Fundamental Aspects of the Design of Knitted Fabrics. *J. Text. Inst.,* **44**, P561 (1953).
2. Munden, D.L., The Geometry and Dimensional Properties of Plain-Knit Fabrics. *J. Text. Inst.,* **50**, T448 (1959).
3. Smirfitt, J.A., Worsted 1 x 1 Rib Fabrics, Part I : Dimensional Properties. *J. Text.,* **56**, T248 (1965).
4. Natkanski, K.B., The Geometry and Dimensional Properties of 1 x 1 Rib Structures, Ph.D. Thesis, Leeds University (1967).

5. Wolfaardt, C., Tumble-Drying as a Relaxation Procedure for All-Wool Knitwear, Part I : The 1 x 1 Rib Structure. *S. African Wool Text. Res. Inst.* Techn. Rep. No. 141 (November, 1970).
6. Wolfaardt, C., Theoretical Determination of the Standard Tightness Factor of the 1 x 1 Rib Structure. *Text. Res. J.,* **40,** 760 (1970).
7. Knapton, J.J.F. and Fong, W., The Dimensional Properties of Knitted Wool Fabrics, Part IV : 1 x 1 Rib and Half-Cardigan Structures in Machine-washing and Tumble-drying. *Text. Res. J.,* **40,** 1095 (1970).
8. Postle, R., Structure, Shape and Dimensions of Wool Knitted Fabrics. *Applied Polymer Symposium* No. 18, 1419 (1971).
9. Knapton, J.J.F. and Schwartzkopff, K.K.H., Dimensional Properties of the All-Wool Punto-di-Roma Structure. *S. African Wool Text. Res. Inst.* Tech. Rep. No. 122 (July, 1969).
10. Postle, R. and Suurmeyer, H.J., The Dimensional, Mechanical and other Physical Properties of Swiss Double Piqué and Punto-di-Roma Wool Fabrics. *Ann. Sci. Text. Belg.* **XXII,** 7 (March, 1974).
11. Knapton, J.J.F., Knitting, High-Quality Double Jersey Cloth IV : Dimensional Properties of the Punto-di-Roma Structure. *Text. Inst. and Ind.,* **11,** No. 12, 345 (Dec., 1973).
12. Knapton, J.J.F., Knitting High-Quality Double Jersey Cloth, Part II : Recommendations for Optimum Run-in and Run-in-Ratio Conditions. *Text. Inst. & Ind.,* **10,** 68 (1972).
13. Knapton, J.J.F. and Schwartzkopff, K.K.H., The Dimensional Properties of All-Wool Double-Knit Fabrics. *S. African Wool Text. Res. Inst. Techn. Rep.* No. 119 (May, 1969).
14. Buys, J.G., The Dimensional Properties of All-Wool Eightlock and Double Eightlock Structures. *SAWTRI Bulletin,* **7,** No. 1, 27 (March, 1973).
15. Knapton, J.J.F., Knitting High-Quality Double-Jersey Cloth VI : The Influence of Structure on Fabric Quality and Dimensions. *Text. Inst. & Ind.,* **12,** No. 9, 273 (1974).
16. Hanekom, E.C. and Barkhuysen, F.A., An Improved Process for the Chlorination of Wool with DCCA. *SAWTRI Bulletin,* **8,** No. 2, 19 (June, 1974).
17. Hanekom, E.C. and Barkhuysen, F.A., – To be published.
18. ISO Second Draft Proposal for Knitting Descriptions (ISO/TC38/SC8/WG3, Sec. 14, No. 18 – Oct., 1969).

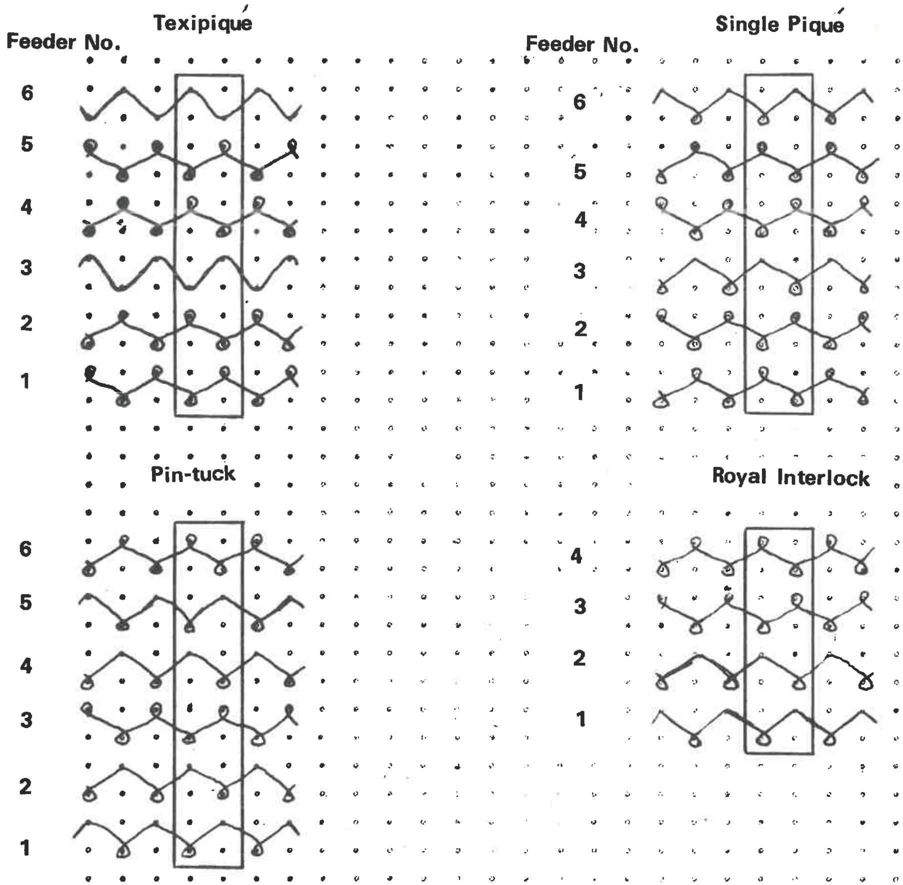



*Fig 1 Schematic diagrams of the various structures (Structural Knit Cells are shown)*

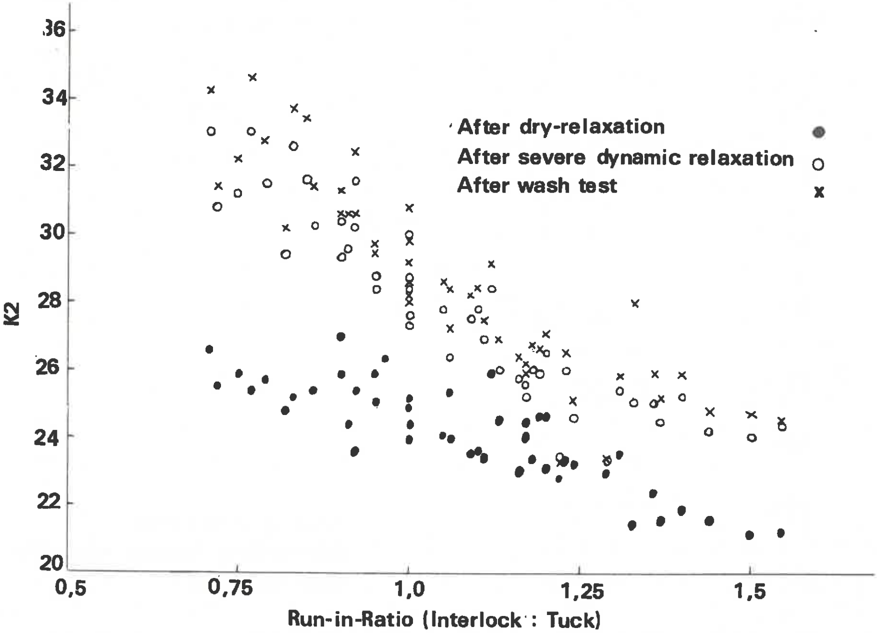



*Fig 2 K2 vs Run-in-Ratio for the Single Piqué structure*

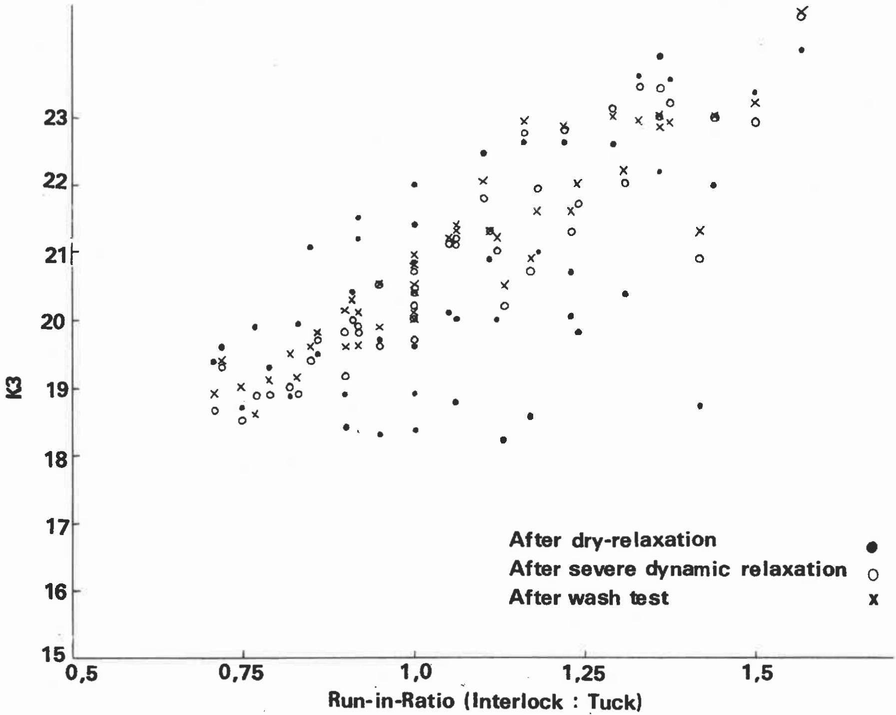



*Fig 3 K3 vs Run-in-Ratio for the Single Piqué structure*

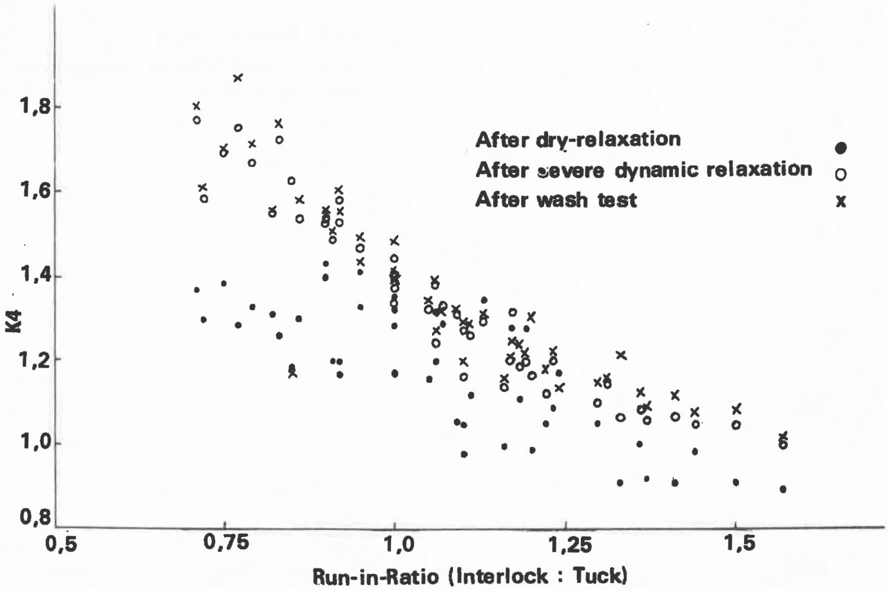



*Fig 4 K4 vs Run-in-Ratio for the Single Piqué structure*

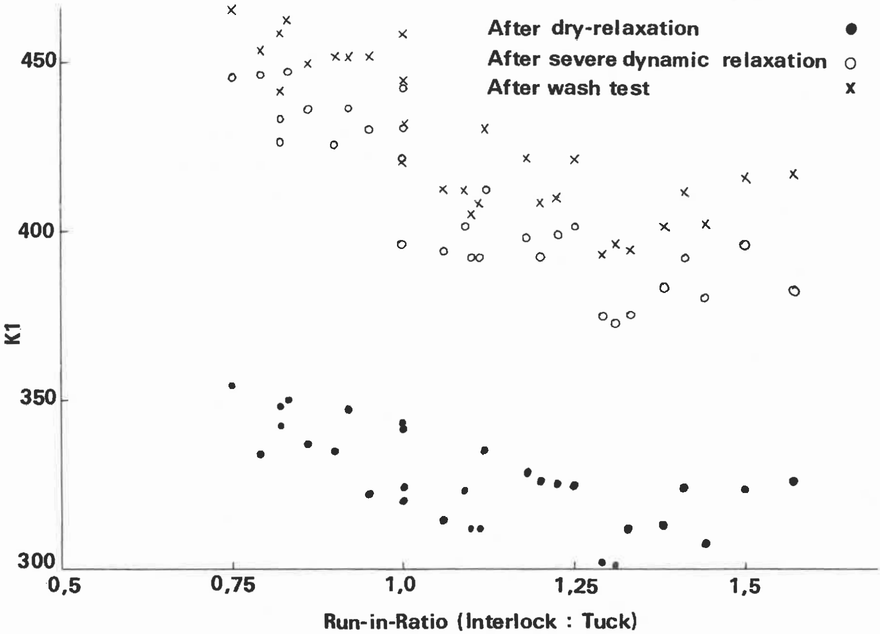



*Fig 5 K1 vs Run-in-Ratio for the Royal Interlock structure*

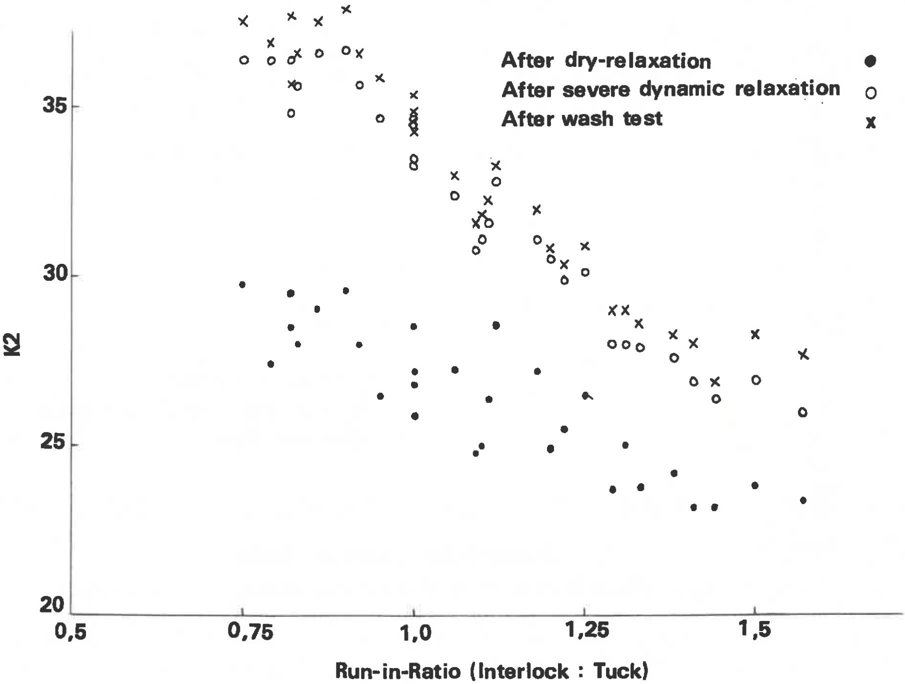



*Fig 6 K2 vs Run-in-Ratio for the Royal Interlock structure*

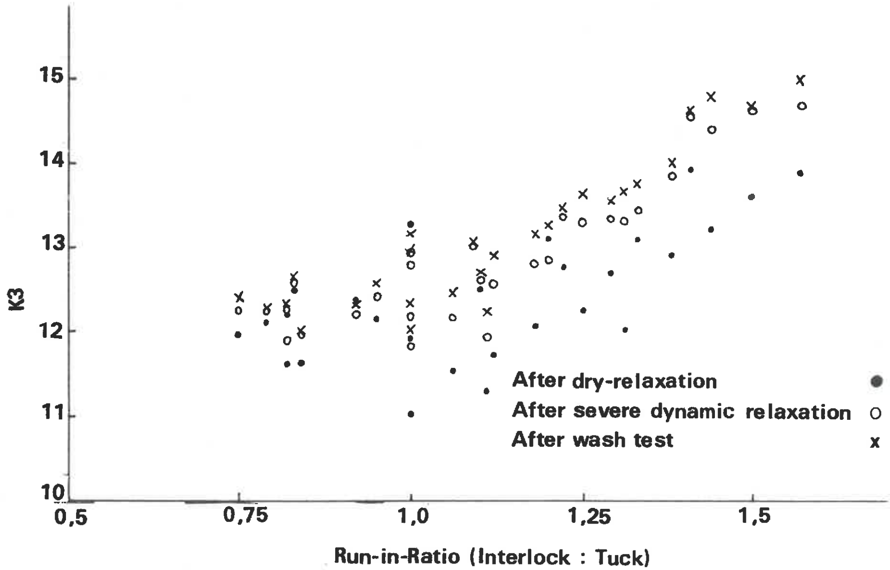



*Fig 7 K3 vs Run-in-Ratio for the Royal Interlock structure*

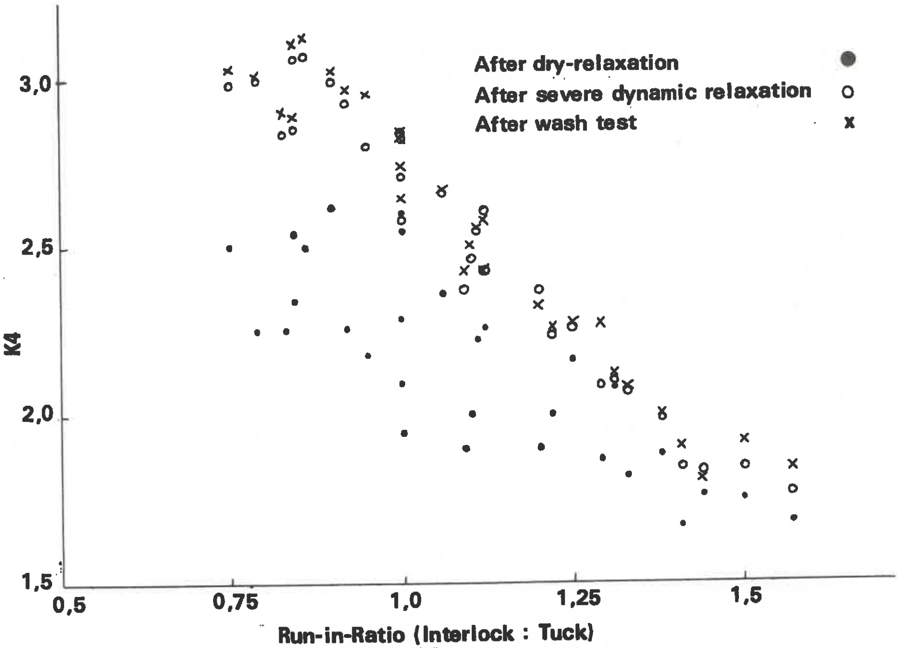



*Fig 8 K4 vs Run-in-Ratio for the Royal Interlock structure*

## TABLE I

### NUMBER OF HOLES OBTAINED PER 500 MACHINE REVOLUTIONS FOR THE DIFFERENT STRUCTURES AT THE VARIOUS RUN-INS (INPUT SPEEDS)

| INPUT SPEED AT TUCK FEEDERS (m/min) | SINGLE PIQUÉ | | | | | ROYAL INTERLOCK | | | | | PIN-TUCK | | | | | TEXIPIQUÉ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Input Speed at Interlock Feeders (m/min) | 90 | 95 | 100 | 110 | 120 | 90 | 95 | 100 | 110 | 120 | 90 | 95 | 100 | 110 | 120 | 90 | 95 | 100 | 105 | 110 | 120 |
| 76,6 | 13* | 2 | 2 | 8 | 19* | + | + | 87 | 3 | 0 | + | + | + | + | + | + | + | + | + | + | + |
| 80 | 11 | 4 | 24 | 10 | 12 | + | + | 41 | 6 | 4 | + | + | + | + | + | + | + | + | + | + | + |
| 85 | 5 | 7 | 19 | 22 | 6 | + | 47 | 7 | 6 | 1 | + | + | 83 | 4 | 8 | + | + | 3 | 13 | 2 | + |
| 90 | 5 | 30 | 10 | 23 | 4 | 31 | 8 | 3 | 0 | 0 | + | + | 67 | 15 | 8 | + | + | 3 | 6 | 3 | + |
| 95 | 32 | 4 | 4 | 2 | 4 | — | — | — | — | — | — | — | — | — | — | + | + | 16 | 2 | 6 | + |
| 100 | 1 | 6 | 6 | 12 | 2 | 9 | 17 | 3 | 7 | 1 | — | 67 | 16 | 15 | 2 | + | + | 3 | + | + | + |
| 110 | 10 | 19 | 3 | 11 | 8 | 10 | 17 | 6 | 1 | 1 | 30 | 20 | 25 | 15 | 7* | + | + | + | + | + | + |
| 120 | 3 | 36 | 2 | 12 | 7 | 0 | 23 | 13 | 2 | 1 | + | + | 23 | 14 | 16 | + | + | + | + | + | + |
| 130 | 10 | 26 | 11 | 4 | 7 | | | | | | | | | | | | | | | | |

* Input tension 4,5 gf

+ Unacceptable fabric or not knittable

— Not knitted

## TABLE II

## "FELTING" SHRINKAGE VALUES OBTAINED AT TWO DIFFERENT TEMPERATURES

| STRUCTURE AND RUN-IN* | RELAXATION SHRINKAGE | | "FELTING" SHRINKAGE ** | |
|---|---|---|---|---|
| | AT 40°C | | AT 60°C | AT 40°C |
| **Royal Interlock** | | | | |
| 110/110 | 22,6 | 20,5 | 3,4 | 6,8 |
| 100/95 | 25,3 | 24,4 | 4,9 | 5,6 |
| 110/120 | 17,0 | 19,6 | 2,7 | 4,7 |
| 90/100 | 20,4 | 22,1 | 3,8 | 5,8 |
| **Pin-Tuck** | | | | |
| 120/120 | 12,2 | 8,5 | 1,4 | 5,3 |
| 120/110 | 12,3 | 10,6 | 4,1 | 5,1 |
| 110/100 | 14,1 | 14,0 | 3,7 | 4,5 |
| **Overall Average** | 17,7 | 17,1 | 3,4 | 5,4 |

* The values indicated in column one refer to the yarn run-in (m/min) at the Tuck and interlock feeders (Tuck/Interlock), respectively.

** Although the test method defines this as felting shrinkage it is considered that, in this particular case, it is residual relaxation shrinkage. (This will be discussed later).

## TABLE III
## CORRELATION COEFFICIENTS BETWEEN THE PARAMETERS LISTED IN COLUMN ONE AND SCSL AND RUN-IN-RATIO, RESPECTIVELY

| DEPENDENT VARIABLE | CORRELATION COEFFICIENTS | | | | | |
|---|---|---|---|---|---|---|
| | AFTER DRY RELAXATION | | AFTER SEVERE DYNAMIC RELAXATION | | AFTER WASH TEST | |
| | SCSL | RUN-IN-RATIO | SCSL | RUN-IN-RATIO | SCSL | RUN-IN-RATIO |
| **Single Piqué** | | | | | | |
| K1 | 0,03 | -0,11 | 0,61*** | 0,13 | 0,49*** | 0,10 |
| K2 | -0,12 | -0,33* | 0,41** | -0,57*** | 0,42** | -0,51*** |
| K3 | 0,66*** | 0,56*** | 0,04 | 0,88*** | -0,04 | 0,91*** |
| K4 | -0,44** | -0,52*** | 0,26 | -0,74*** | 0,22 | -0,67*** |
| Length Shrinkage | — | — | 0,68*** | -0,49*** | 0,60*** | -0,43** |
| Width Shrinkage | — | — | -0,91*** | 0,23 | -0,94*** | 0,08 |
| Area Shrinkage | — | — | -0,27 | -0,48*** | -0,45** | -0,36* |
| **Royal Interlock** | | | | | | |
| K1 | 0,39* | -0,73*** | 0,48** | -0,85*** | 0,38* | -0,81*** |
| K2 | -0,01 | -0,87*** | 0,31 | -0,98*** | 0,31 | -0,97*** |
| K3 | 0,39* | 0,68*** | -0,10 | 0,90*** | -0,19 | 0,93*** |
| K4 | -0,19 | -0,81*** | 0,24 | -0,97*** | -0,23 | -0,97*** |
| Length Shrinkage | — | — | 0,69*** | -0,78*** | 0,70*** | -0,75*** |
| Width Shrinkage | — | — | -0,90*** | 0,57*** | -0,93*** | 0,56** |
| Area Shrinkage | — | — | 0,18 | -0,70*** | -0,11 | -0,54** |
| **Pin-tuck** | | | | | | |
| K1 | 0,65** | -0,83*** | 0,61** | -0,65** | 0,36 | -0,72*** |
| K2 | 0,44 | -0,93*** | 0,70*** | -0,82*** | 0,61** | -0,90*** |
| K3 | 0,40 | 0,37 | -0,08 | 0,35 | -0,23 | 0,40 |
| K4 | 0,21 | -0,88*** | 0,56* | -0,76*** | 0,56* | -0,86*** |
| Length Shrinkage | — | — | 0,16 | 0,63** | 0,07 | 0,43 |
| Width Shrinkage | — | — | 0,83*** | 0,27 | 0,87*** | 0,35 |
| Area Shrinkage | — | — | 0,52* | 0,88*** | 0,76*** | 0,55* |
| **Texipiqué** | | | | | | |
| K1 | 0,31 | -0,82** | 0,34 | -0,76* | 0,24 | -0,81** |
| K2 | 0,42 | -0,92*** | -0,15 | -0,92*** | -0,18 | -0,92*** |
| K3 | 1,00*** | 0,19 | 0,15 | 0,33 | -0,42 | -0,09 |
| K4 | -0,78** | -0,72* | -0,63* | -0,75* | -0,60 | -0,73* |
| Length Shrinkage | — | — | -0,66* | -0,69* | 0,70* | 0,71* |
| Width Shrinkage | — | — | -0,71* | -0,62* | -0,68* | -0,65* |
| Area Shrinkage | — | — | 0,04 | 0,14 | -0,24 | -0,10 |

*** Significant at the 0,1% level
** Significant at the 1% Level
* Significant at the 5% level

The number of readings in each case was as follows:
Single Piqué : 48; Royal Interlock : 30
Pin-tuck : 18; Texipiqué : 10

*Results* and *Discussion* for a temperature of 60°C are, therefore, probably equally valid for a temperature of 40°C.

## TABLE IV
## AVERAGE VALUES FOR THE SINGLE PIQUÉ STRUCTURE

| PARAMETER | AFTER DRY-RELAXATION | | AFTER SEVERE DYNAMIC RELAXATION | | AFTER WASH TEST* | |
|---|---|---|---|---|---|---|
| K1 | 490 | (14,6) | 576 | (7,3) | 596 | (7,4) |
| K2 | 24,0 | (6,9) | 28,0 | (9,7) | 28,4 | (10,0) |
| K3 | 20,5 | (7,9) | 20,6 | (6,8) | 21,0 | (6,3) |
| K4 | 1,18 | (12,5) | 1,36 | (15,4) | 1,36 | (15,0) |
| SCSL | 4,35 | | – | | – | |
| Run-in-Ratio | 1,07 | | – | | – | |
| Length Shrinkage (%) | – | | 10,3 | (30,2) | 13,0 | (25,0) |
| Width Shrinkage (%) | – | | 3,1 | (112,9) | 3,2 | (121,7) |
| Area Shrinkage (%) | – | | 12,9 | (15,0) | 15,9 | (17,6) |
| Fabric width (in cm) at average SCSL and Run-in-Ratio | 181 | | 181 | | 176 | |

CV values are given in parenthesis.

* The shrinkage values given in the last column represent the total shrinkage which occurred from the dry-relaxed state until after the wash test and therefore include the relaxation shrinkage values shown in the second last column.

## TABLE V

## AVERAGE VALUES FOR THE ROYAL INTERLOCK STRUCTURE

| PARAMETER | AFTER DRY-RELAXATION | | AFTER SEVERE DYNAMIC RELAXATION | | AFTER WASH TEST* | |
|---|---|---|---|---|---|---|
| K1 | 324 | (6,8) | 409 | (5,9) | 427 | (5,4) |
| K2 | 26,4 | (7,9) | 31,9 | (10,9) | 32,8 | (10,7) |
| K3 | 12,4 | (5,9) | 12,9 | (6,6) | 13,1 | (6,7) |
| K4 | 2,1 | (13,0) | 2,5 | (16,5) | 2,5 | (62,8) |
| SCSL | 2,91 | | – | | | |
| Run-in-Ratio | 1,11 | | – | | – | |
| Length Shrinkage (%) | – | | 16,9 | (24,9) | 19,2 | (19,8) |
| Width Shrinkage (%) | – | | 3,4 | (94,1) | 4,9 | (74,9) |
| Area Shrinkage (%) | – | | 19,9 | (11,7) | 23,2 | (8,3) |
| Fabric width (in cm) at the above SCSL and Run-in-Ratio values | 200 | | 192 | | 189 | |

CV values are given in parenthesis.

* The shrinkage values given in the last column are the total which occurred from the dry-relaxed state to the end of the wash test and include the relaxation shrinkage values shown in the second last column.

## TABLE VI

## AVERAGE VALUES FOR THE PIN-TUCK STRUCTURE

| PARAMETER | AFTER DRY-RELAXATION | | AFTER SEVERE DYNAMIC RELAXATION | | AFTER WASH TEST* | |
|---|---|---|---|---|---|---|
| K1 | 599 | (6,3) | 701 | (4,5) | 723 | (5,0) |
| K2 | 32,0 | (6,8) | 37,5 | (5,4) | 38,5 | (5,9) |
| K3 | 18,7 | (2,9) | 18,7 | (3,2) | 18,8 | (3,4) |
| K4 | 1,71 | (8,2) | 2,01 | (7,1) | 2,05 | (7,7) |
| SCSL (cm) | 4,49 | | — | | — | |
| Run-in-Ratio | 1,06 | | — | | — | |
| Length Shrinkage (%) | — | | 14,1 | (17,5) | 16,3 | (10,6) |
| Width Shrinkage (%) | — | | 0,6 | (382) | 1,2 | (226,8) |
| Area Shrinkage (%) | — | | 14,6 | (15,7) | 17,2 | (14,9) |
| Fabric width (in cm) at average SCSL and Run-in-Ratio | 205 | | 205 | | 203 | |

CV values are given in parenthesis.

* The shrinkage values given in the last column are the total which occurred from the dry-relaxed state to the end of the wash test and include the relaxation shrinkage values shown in the second last column.

## TABLE VII

### AVERAGE VALUES FOR THE TEXIPIQUÉ STRUCTURE (ALL THESE ARE APPROXIMATE ONLY)

| PARAMETER | AFTER DRY-RELAXATION | | AFTER SEVERE DYNAMIC RELAXATION | | AFTER WASH TEST * | |
|---|---|---|---|---|---|---|
| K1 | 554 | (4,0) | 646 | (10,1) | 680 | (4,3) |
| K2 | 27,2 | (4,2) | 29,3 | (3,1) | 30,1 | (3,4) |
| K3 | 20,4 | (3,0) | 22,1 | (5,4) | 22,6 | (6,5) |
| K4 | 1,3 | (6,1) | 1,3 | (3,6) | 1,3 | (3,8) |
| SCSL (cm) | 4,30 | | – | | – | |
| Run-in-Ratio | 1,15 | | – | | – | |
| Length Shrinkage (%) | – | | 8,5 | (24,9) | 11,3 | (15,7) |
| Width Shrinkage (%) | – | | 6,3 | (30,3) | 8,1 | (27,7) |
| Area Shrinkage (%) | – | | 14,1 | (9,2) | 18,5 | (7,8) |
| Fabric width (in cm) at average SCSL and Run-in-Ratio | 180 | | 165 | | 160 | |

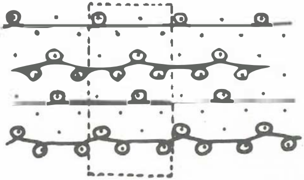
CV values are given in parenthesis.

* The shrinkage values given in the last column are the total shrinkages which occurred from the dry-relaxed state to the end of the wash test and include the relaxation shrinkages values shown in the second last column.

FABRIC DETAILS:

**1. French double piqué**

| | | |
|---|---|---|
| Mass per unit area | = | 320 g/m² |
| Composition | : | 60 *per cent* cotton/40 *per cent* polyester |
| Run-in-ratio | : | 2,1 : 1 (126,9 m/min : 60,4 m/min) |
| No. of feeders | : | 4 |
| Yarn input tension | : | Feeders 2 and 4 (cotton) – 3gf |
| | | Feeders 1 and 3 (polyester) – 4gf |



**Feeder No.**

4. R48 tex S380/2Z720 all cotton
3. 167 dtex f30 textured polyester
2. R48 tex S380/2Z720 all cotton
1. 167 dtex f30 textured polyester