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INFLUENCE OF YARN TWIST LEVEL ON THE REFERENCE DIMENSIONS OF WINCH BLEACHED 20G INTERLOCK FABRICS

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C O N T E N T S

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1. INTRODUCTION

A collaborative research project had been arranged by Bill Cooke, lecturer in knitting technology at UMIST, with Dr. Samir Kamal of Helwan University, Cairo, to investigate the influence of fabric tightness factor and yarn twist factor on the dimensions and properties of cotton interlock fabric.

The spinning of the yarn and knitting of the fabric was organised by Dr. Kamal and carried out in Egypt. The fabric samples were then sent to UMIST for testing and evaluation during June (?) 1985.

On receipt of the samples and knowing of our work on cotton knitgoods, Bill Cooke contacted TRD to discuss the project and in particular obtain advice regarding finishing. Unfortunately, the lengths of fabric involved (approximately 5m per quality) made a commercial finishing operation impractical. However, as this was a rather unique set of fabrics and provided an ideal opportunity to gather more information regarding the effect of yarn twist on fabric dimensions it was agreed that IIC would process the fabric for UMIST, using the Shirley equipment. In return half the samples would be retained by TRD for our own testing and evaluation, while the remainder would be returned to UMIST.

UMIST were planning to investigate the influence of the yarn and structural variables on such properties as drape, permeability, crease recovery, handle (Kowabata) etc. On completion, the results obtained by both laboratories would be exchanged.

2. YARN

The yarn used in this project was specially spun by a mill in Egypt, to a nominal count of Ne 1/30 from combed Giza 77 fibre (15% comber waste), and to five different nominal twist factors 3.0, 3.2, 3.4, 3.6 and 3.8.

Table 1 contains the yarn testing details supplied by Dr. Kamal.

3. KNITTING

The fabric samples were knitted at the University of Helwan, Cairo, under the supervision of Dr. Kamal, using a 30 inch, 20 gauge interlock machine, model Jumberca 8ML2, with 72 feeders and 1896 x 1896 needles. The machine was fitted with positive feed.

Five nominal tightness factors ($\sqrt{\text{tex}}/1$); 11, 12, 13, 14, and 15 were knitted from each twist level.

Each quality was produced in approximately 5m lengths in 5 rolls, by setting a tightness factor and changing yarn. Each quality was separated by a coloured thread.

The knitting details supplied by Dr. Kamal are given in Table 2.

4. FINISHING

The bleaching and finishing operations were carried out by TRD personnel using the Shirley equipment. All 25 variants were processed together in a Leemetal winch, scoured and bleached, hydroextracted, hand slit and dried open-width on the stenter.

STARFISH was used to calculate average target widths for each quality, assuming 10% width shrinkage, but due to the very short lengths involved, an overall average target width was calculated and all the qualities were dried at this width - approx. 160cm.

The samples were assembled for drying in a continuous length in ascending width order according to tightness. At the time of processing a suitable softener was not available for inclusion during the winch processing and the padder could not be used prior to drying. Consequently, the fabrics were finished without softener.

Details of the bleaching and finishing operations are given in Table 3.

5. SAMPLING AND TESTING

After drying the samples were separated by quality and cut in half; half was retained at TRD and the other half was returned to UMIST.

5.1. Yarn Testing

One small cone of each twist level was obtained from UMIST. In all cases there was insufficient sample to enable standard IIC yarn testing methods to be followed exactly. However, each cone was tested for tex, turns per metre, single end strength and % extension, friction against steel and twist liveliness. The results are given in Table 4.

5.2. Fabric Testing

Grey fabric could not be tested prior to finishing due to the size of the samples available. However full testing was carried out on each finished sample both as received and after relaxation to the reference state. Due to the limited amount of fabric, shrinkage was measured on five specimens using the 25cm sq. template.

5.3. Observations

Some samples showed differences between calculated and measured weight, especially in the reference state. Retesting was carried out to try to correct the situation where sufficient sample remained. However in some cases there are still differences of more than ± 5%. The reasons for the discrepancies cannot be fully identified but are probably due to:-

1) variation in the original fabrics
2) size of sample available for reference relaxation
3) variation in processing condition due to the very short lengths of each quality which were available.

The laboratory also reported difficulty in extracting yarn for measuring yarn count and stitch length and some difficulty in cutting the weight samples. This may have been due to the absence of softener.

The full test data are given in Table 5.

6. RESULTS

6.1. Yarn

Specimens of yarn were extracted from the fabric samples and measured for count, turns per metre, strength and extension both before and after relaxation to the reference state. Alpha Tex and English twist factor were calculated from the individual results. The mean and standard deviatons were calculated for each yarn twist factor variant over tightness factor on the grounds that the yarn source was the same in each case and therefore each stitch length variant could be treated as a separate replication from the same yarn sample. (Table 6). An examination of the mean and standard deviations for turns per metre suggested that there was no significant difference between the before and after wash measurements. This was confirmed statistically (Table 7) and therefore the results were averaged for turns per metre and twist factor (Table 8). The change in yarn tex during relaxation was found to be significant, therefore for the purposes of this analysis the after wash or reference state tex measurements have been used.

The overall % coefficient of variation for yarn count measured after relaxation was found to be CV = 1.33% which is within acceptable commercial tolerances for yarn count variation. However, a comparison of the results for each twist level indicated statistically significant differences between the 3.0 twist factor yarn and the 3.2 and 3.8 twist factor yarns, although the actual mean differences in tex were small (Table 9). Consequently, because variation in average yarn count between pieces knitted to the same average loop length will influence reference dimensions it was decided to use the yarn count averaged over each twist factor for analytical purposes, where appropriate, rather than the count averaged over all twist levels.

6.2. Stitch Length

The variation in stitch length between samples knitted to the same nominal tightness factor from yarns of different twist levels was found to be insignificant and therefore the results were averaged across yarn twist levels.

6.3. Dimensions

To establish if there was an influence of yarn twist level on the average dimensions of the reference state, a statistical test for significance was run between the samples knitted from each twist level. The basic data is given in Table 10. Tables 11-14 give the results for courses, wales, weight and stitches respectively.

The results show significant differences depending on yarn twist factor for courses, and with one exception for weight and stitches. The results for

wales are inconclusive. There is a significant difference between Twist factor 3.2 and 3.6 and 3.2 and 3.8 at the 95% level but this is not repeated between the other levels.

6.4. Shrinkage

Fabric shrinkage was measureed on the samples after 1 cycle of washing and tumble drying and after relaxation to the reference state. Tables 15 and 16 give the results after 1 and 5 cycles. Table 15 gives the data arranged by tightness factor, Table 16 gives the data arranged by twist factor.

Figures 1 and 2 show plots of shrinkage after 1 cycle versus 5 cycles for length and width respectively.

Length shrinkage is consistently underestimated by the 1 cycle test, although there is a suggestion that at lower shrinkage levels - higher tightness - the differences are becoming smaller.

Width shrinkage, on the other hand, is almost always overestimated by the 1 cycle test. At higher shrinkage levels - higher tightness - there is little or no difference between 1 and 5 cycles but at low width shrinkage levels - low tightness levels - an apparent small width shrinkage after 1 cycle is converted to a width extension or growth after 5 cycles. This type of behaviour has been observed previously on double jersey fabrics, although it is more usually associated with 1 x 1 rib constructions. It does however appear to confirm previously held views that it is inadvisable to aim for a width shrinkage to a tumble test of less than approximately 6% if problems associated with width growth or extension are to be avoided during repeat launderings. It also suggests that at tightness factors less than approximately K = 13 the fabric may be dimensionally unstable in the width direction.

Due to the very short lengths of each sample available for processing, and in consequence the problems associated with processing small samples of different constructions uniformly and at optimum conditions, the absolute shrinkage values should not be regarded as of any great significance. However as all the samples were dried at the same width on the stenter and with maximum overfeed, an indication of the influence of twist and tightness on final fabric shrinkage can be obtained. Figure 3 shows length and width shrinkage for each sample plotted against average reference stitch length. It is interesting to note that in general terms higher twist and higher tightness give a better balance of shrinkage length to width than lower twist and lower tightness. The influence of yarn twist on reference dimensions is reflected in the vertical displacement of the data points. This would also appear to indicate that the influence of yarn twist may be more significant at longer loop lengths than at shorter loop lengths.

7. COMPARISON WITH STARFISH 84

Figures 4 - 7 show the data for courses, wales, weight and stitches respectively, compared to the current STARFISH 84 prediction equation for reference state winch bleached interlock fabrics.

The coefficients for this equation were developed for winch bleached and tubular processed 20 and 28 gauge interlock fabrics knitted at a range of stitch lengths and from a range of combed, ring-spun yarn counts (Ne 1/34 - Ne 1/70). The yarns used for the 20 gauge interlock had an average twist factor in the yarn of 3.5 and for the 28 gauge interlock an average twist factor in the yarn of 3.8.

The plot for courses, Figure 4, appears to pass approximately through the centre of the data, which would indicate that on average the current model is predicting average reference courses reasonably well. However, a closer inspection suggests that in fact the prediction line is both slightly biased towards the higher twist levels and also that the slope is not entirely correct. The displacement of the data points according to yarn twist level does however confirm that the additional influence of yarn twist on reference dimensions, i.e. higher twist factor, more courses, lower twist factor, less courses - should ideally be taken into account in the prediction equation to enable greater precision to be achieved.

The plot for wales, Figure 5 - indicates that the current STARFISH model is consistently underestimating the references wales measured in these fabric samples. That is, we are predicting a wider fabric, on average, than would in fact be obtained. Similarly to courses however, there is an indication from the vertical displacement of the data points that there is an additional influence of yarn twist on reference wales. There is also a suggestion that the influence of yarn twist is more predominant at longer loop lengths, i.e. longer loop length - higher twist - more wales. The relative inconsistency in the data however does not allow conclusive judgements to be made, as illustrated previously in the statistical analysis of wales according to twist level which generally did not show significant differences.

The plot for fabric weight - Figure 6 - similarly to courses, indicates that on average the current STARFISH equation is performing reasonably well. However, there is again a suggestion that the slope of the equation is not entirely correct, with a bias at short loop lengths towards the high twist factor. Similarly to courses however, the vertical displacement of the data points again suggests an additional influence of yarn twist on reference weight.

The plot for stitches - Figure 7 - is on average underestimating observed dimensions in this data set, although in this instance the slope of the curve appears to be more or less correct. The underestimate of stitches is not unexpected from the previous comparison with reference wales. The influence of yarn twist factor can still be seen in the vertical displacement of the data points, i.e. higher twist - more stitches, lower twist - less stitches.

An indication of the source of some of the discrepancy between predicted and observed dimensions can be obtained from Figures 8 - 11.

Figure 8 shows reference courses through which are plotted 3 regression lines. No. 1 illustrating the equation developed from the 28 gauge interlock winch bleached data set, No. 3 showing the average equation developed for

the 20 gauge interlock winch bleached and winch bleached compacted data sets and No. 2 the equation developed from both sets of data combined.

Figures 9, 10 and 11 show similar plots for wales, weight and stitches respectively. The coefficients are given in Table 17.

In the case of courses and wales the equation developed on the 28 gauge data set, which was knitted using yarn with an average twist factor of 3.8, passes through, or very close to, the measured values for the fabrics in this set knitted from yarn with a nominal twist factor of 3.8. The average line for the 20 gauge data set passes closer to the values obtained from the 3.4 twist factor set. For fabric weight the 20 gauge line again describes the middle twist factor range most accurately while the 28 gauge line is biased towards the high twist end at short loop lengths. For stitches both 20 and 28 gauge equations are underestimating the observed values, the average equation is actually performing somewhat better.

From these results therefore it is obvious that by combining the data sets without recognising the additional influence of yarn twist on reference dimensions some unintended bias has been introduced which has led to quite serious inaccuracies, especially in the prediction of reference wales, and in all cases when extrapolating to yarn counts or stitch length on the edge or outside the existing data base. This may offer some explanation for the one or two examples of inaccurate predictions which have occurred in the past for interlock fabrics.

8. PRELIMINARY ANALYSIS

The previous sections have indicated that there is an influence of yarn twist on reference dimensions, and that the accuracy of the existing STARFISH equations could be improved if it were possible to include an additonal term in the equations which would account for this influence. Consequently a series of regression analyses were carried out in an attempt to identify the appropriate additional term which could be included in the equation to accommodate the influence of yarn twist.

1. Model $y = a + bx$

   where x = 1/l for courses and wales
   tex/l for weight
   $1/l^2$ for stitches

In the first series of calculation each twist level was treated independently and, using the model described above, regression coefficients calculated. By treating each twist level separately, the independent influence of twist or tex is in fact ignored and a series of equations are developed which describe the dimensions of the fabrics as they relate to stitch length. Table 18 and Figures 12-15 show the results of the analysis. In all cases the correlation coefficients indicate that the model is describing the data reasonably accurately but an examination of the figures confirms that in order to describe the whole data set with one equation. some additional term is required.

In the next 3 series, the data was grouped across tightness factor, which essentially removes the independent influence of stitch length on dimensions and allows the relative importance of various twist related terms to be examined. Table 19 gives the basic data.

2. Model $y = a + bx$ Table 20, Figures 16-19

   where x = turns per metre (measured in yarn extracted from the fabric, averaged before and after wash).

3. Model $y = a + bx$ Table 21, Figures 20-23

   where x = alpha Tex (calculated from average reference tex and average turns per metre measured in yarn taken from the fabric).

4. Model $y = a + bx$ Table 22, Figures 24-27

   where x = Twist liveliness T/L (measured on the original yarns from cone).

On average the model which uses turns per metre gives the best overall correlation coefficients for each property across tightness factors and therefore suggests that some function of turns per unit length could be used in a multiple linear regression analysis with stitch length to adequately describe the data obtained from this set of fabrics.

9. MULTIPLE LINEAR REGRESSION ANALYSIS

Table 23 gives the basic data.

As a first step the simple model

$y = a + bx$ where $x = 1/l$ for courses and wales
$1/l^2$ for stitches
tex/l for weight

was re-run on the whole data set to establish the average regression lines, and then repeated for courses, wales, and stitches using the existing STARFISH model equations.

i.e. $y = a + b/l + C.\sqrt{tex}$ for courses and wales

$y = a + b/l^2 + C.\ tex$ for stitches

The coefficients and correlation coefficients are given in Table 24.

The second step was to repeat the analysis using some function relating to yarn twist as the second term in the equation.

1. Model $y = a + b(x1) + c(x2)$

   where x1 = 1/l for courses and wales
   $1/l^2$ for stitches
   tex/l for weight

   and x2 = turns per centimetre

2. Model $y = a + b(x1) + C(x2)$

   where x1 = 1/l for courses and wales
   $1/l^2$ for stitches
   tex/l for weight

   and x2 = turns per loop (i.e. turns per centimetre * stitch length)

3. Model $y = a + b(x1) + c(x2)$

   where x1 = 1/l for courses and wales
   $1/l^2$ for stitches
   tex/l for weight

   and x2 = alpha tex (i.e. turns per centimetre * square root tex)

The coefficients and correlation coefficients are given in Table 25

Finally, the analysis was re-run using the basic STARFISH equations plus an extra term relating to yarn twist, i.e. turns per centimetre.

Model $y = a + b(x1) + c(x2) + d(x3)$

where x1 = 1/l for courses and wales
$1/l^2$ for stitches

where x2 = $\sqrt{\text{tex}}$ for courses and wales
tex for stitches

and x3 = turns per centimetre

The coefficients and correlation coefficients are given in Table 26.

On the evidence of the above it would appear that by including an additional term in the equation which relates in some way to the amount of twist in the yarn it should be possible to improve the overall accuracy of the STARFISH model. Unfortunately, as this data set was produced from yarn having approximately the same yarn count it is not possible to test whether in fact any of the proposed terms would work for fabrics produced from various yarn counts. However as the particular influence of yarn count can probably be ignored in this data set the models which explain the differences in dimensions in terms of stitch length and some function of turns per centimetre probably give a good indication of the potential importance of the extra term to a model which can be used to describe 'all' fabrics.

It may be that the form of the additional term should in fact be different for each property. For example, the model which uses turns per loop gives both the highest r^2 and smallest intercept 'ā' for wales, where the influence of twist on dimensions appears to be modified according to loop length, i.e. the effect is apparently greater at longer loop lengths than at shorter loop lengths. On the other hand, turns per centimetre or alpha tex may be more appropriate to describe the influence of twist on courses.

On the average however there is little to choose between the 3 models in terms of their correlation coefficients; all are describing the data with a similar degree of precision and a much more extensive data set would be needed to test which in fact was the most appropriate term. Consequently for illustration the model which includes the simplest twist related term, i.e. turns per centimetre is used for Figures 28-31. This term was also chosen to illustrate the improvement in r^2 which can be achieved by including some function of twist in the basic STARFISH model equations.

10. DISCUSSION

Our main objective in becoming involved with this project was to gather some additional systematic information regarding the influence of twist on the dimensions of cotton interlock fabrics. Previous work has shown that for single jersey fabrics, differences in both the angle of spirality and reference dimensions can be observed when fabrics knitted to the same average loop length, from yarns of the same count but different twist levels are compared, e.g. based on the average reference courses and wales for 24 gauge single jersey knitted at a nominal loop length of 0.321 cm and from a nominal yarn count of Ne 1/28 twist factor 3.5, the difference in reference dimensions between similar fabrics knitted from twist factor 3.0 and 4.0 are 4.6% for courses and 3.7% for wales. However as we had not had the opportunity to study the influence of twist on double jersey fabrics, we had no information regarding whether the effect would be more or less significant. Consequently, this particular set provided an ideal opportunity to obtain an indication of the potential size of the problem.

Unfortunatley, limitations in the size of the original samples and in consequence the problems involved in obtaining proper control and optimised conditions during finishing means that there must be a degree of uncertainty in the test results. It also means that it would be unwise to draw definite conclusions without further, more controlled trials on larger samples. However, the results of this study have been useful for several reasons:

1) The data has shown that the influence of yarn twist factor is not only restricted to single jersey fabrics, and in particular spirality, but can also have a significant influence on the reference dimensions of cotton interlock fabrics.

2) It has enabled an additional source of variation in reference dimensions to be better identified and as a result pointed out a potentially serious inaccuracy in the existing STARFISH model.

3) It has provided the opportunity to examine ways of incorporating the influence of twist into the model.

4) It has enabled a better insight to be obtained into the mechanism by which twist influences dimensions.

5) It has confirmed the need for more controlled and extensive trials to evaluate the effect of twist on interlock, rib and jersey fabrics, so that this aspect of fabric behaviour can ultimately be included in future versions of the STARFISH model.

Differences in reference dimensions are the direct result of the torsional forces in a spun yarn causing the knitted loops to distort, twist and incline out of the plane of the fabric. In jersey fabrics this effect is the main cause of fabric spirality. In interlock fabrics the loops on either side of the fabric distort in opposite directions which has a sort of concertina effect on the fabric, allowing the loops to become more tightly packed. For yarns of similar quality the torsional forces in the yarn can be related to the number of turns in the yarn. Consequently, a yarn with more turns per unit length will cause the loops to distort more than a yarn with less turns per unit length. Obviously, at shorter loop lengths, the movement of the yarn in the loop is more restricted than at longer loop lengths, therefore the influence of twist is relatively small. At longer loop lengths however, where the loop has more freedom of movement, higher twist levels will create larger distortions.

An indication of this effect can be seen from Figures 32 and 33 which show fabric thickness plotted against average loop length and average turns per centimetre respectively. In particular in Figure 33 as the number of turns per loop (turns per cm x loop length) increase, the thickness of the fabric increases. At the longest loop length (tightness factor 11) the difference between twist factors is much more marked than at the shortest loop length (tightness factor 15).

A series of photographs taken of some the 25 fabric samples also show differences in the loop shape according to tightness and twist factor.

The absolute size of the influence of twist on fabric dimensions cannot be accurately estimated from this data set but on average, at a nominal tightness factor of K = 13, the difference in reference courses knitted from 3.0 twist factor compared to 3.8 twist factor is 1 course or 6.7% based on the number of courses measured for 3.4 twist factor yarn, and 0.4 wales or 2.9% based on the number of wales measured for 3.4 twist factor yarn. At tightness factor 11 however, the difference in wales is 1 wale or 7.3%. In addition, the influence of twist also appears to be more pronounced at higher twist levels, e.g. the difference in dimensions between 3.0 and 3.4 are less than between 3.4 and 3.8, 2.7% and 4% for courses and 0% and 2.9% for wales respectively.

11. CONCLUSIONS

1. On the basis of this data set it appears that there is an additional influence of yarn twist factor on the reference dimensions of 20G interlock fabrics, e.g. higher twist factor, more courses, more wales, more stitches, heavier fabric.

2. There is also an indication that the influence of yarn twist may be dependent on the loop length especially for the wales, e.g. relatively higher twist factors at longer loop lengths have a bigger effect on reference wales than at shorter loop lengths.

3. The existing STARFISH model for winch bleached interlock, although performing reasonably well on the average for courses and weight, is underestimating wales and stitches.

4. One can speculate that the reasons for this are due to:

   1) high variation in reference width due to the small size of the samples available for processing and testing,

   2) differences in the reference state brought about by the conditions of bleaching and finishing which were dissimilar between this data set and the STARFISH data base fabrics,

   3) independent influence of fibre type.

   However, the most likely reason appears to be related to the disparity in yarn twist in the two original data sets, 28 gauge and 20 gauge, which when combined to calculate the coefficients of the current STARFISH model have introduced bias in the equation.

5. A preliminary analysis has shown that it should be possible to account for the additional influence of yarn twist factor on reference dimensions by including an additional term in the STARFISH model which is related to the number of turns per unit length in the yarn.

6. No attempt has been made to relate the turns in the grey yarn to finished reference dimensions for two main reasons:

   a) the original yarn samples were too small to be confident that the results adequately reflected the properties of the bulk of the yarn,

   b) without grey fabric samples the influence of knitting and finishing on the twist in the yarn in the fabric could not be assessed.

7. In order to improve the accuracy of the current interlock model, a re-evaluation of the data analysis should be carried out to ensure that on average predictions are as accurate as possible. The 28 gauge equation may serve as a better model for the 20 gauge data in terms of courses and wales if the influence of yarn twist is either ignored or can be accounted for.

8. The potential for including an extra term which takes into account the influence of yarn twist should be examined. Preliminary data to achieve this can be obtained by measuring turns per metre before and after relaxation in the existing winch processed interlock data base fabrics. Supplementary data on yarn, grey and finished fabric could be obtained by setting up a case study which, if possible, would contain yarns of different twist factors.

9. The influence of twist factor on the dimensions of 1 x 1 rib fabrics needs to be investigated.

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TABLE 1

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30

Helwan Test Data :- Yarn Test Data

Yarn Count	Ne 1/30				
Twist Factor	3.0	3.2	3.4	3.6	3.8
Measured Ne	30.5	30	29.9	30.3	29.9
CV%	2.55	2.82	2.4	2.45	3.44
Turns/inch	16.58	17.75	18.2	19.35	21.15
CV%	2.5	3.8	2.59	4.95	2.87
WorkDoneg*cm	370.11	406.35	450.02	486.41	545.23
CV%	14.77	15.54	11.94	17.16	12.62
Strength g	286.6	316.8	344.3	363.5	401.3
CV%	11.01	10.9	8.45	11.9	8.4
R.K.M.	14.8	16.09	17.43	18.65	20.32
Elongation %	5.09	5.17	5.27	5.58	5.54
CV%	5.92	7.99	5.86	7.63	6.79
Appearance	B-	B	B	B	B
Neps/1000m	27	28	34	23	25
Thick/1000m	21	26	28	20	25
Thin/1000m	1.3	3.6	2.6	0.8	2.8
Uster U%	13.24	13.33	13.22	13.01	13.57

TABLE 2

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30

Helwan : Nominal Knitting Machine Settings

	1	2	3	4	5
Pully Index	100	107	115.2	125	139
Stitch cam	5	7	9	11	13
M.T.F.	15	14	13	12	11
C.L./cm	565	605	652	706	770
Rev/exp	100	100	100	100	100

TABLE 3

FINISHING DETAILS

LEEMETAL WINCH

Scour

2g/l Triton X-155 (detergent) at 90°C for 30 mins. Hot & Cold Rinse

Bleach

8cc/l Hydrogen Peroxide
5g/l soda ash
0.5g/l caustic soda
7g/l sodium silicate
0.3% o.w.f. Uvitex CF

Raise temperature to 80°C. Hold at 80°C for 90 minutes. Hot & Cold rinses.

Neutralise with acetic acid

Hydroextracted

Slit

Stenter dry to 160cms at 140°C.

TABLE 4

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30

IIC Test Data :- Yarn Data from Cone

Nominal Twist Factor	Tex	cc	Tpm	aTex	TwFe	T/L	YnStr	%Ext	F'tn
3.0	18.8	31.5	728	31.5	3.3	52.1	253.1	5.9	0.14
3.2	20.5	28.9	734	33.2	3.5	60.1	373.6	6.4	0.11
3.4	19.2	30.7	770.4	33.7	3.5	61.9	358.9	6.2	0.1
3.6	20.1	29.3	820.5	36.8	3.8	62.4	389.4	6.4	0.1
3.8	20.5	28.8	809.1	36.7	3.8	68	405.6	6.4	0.1

Key to Abbreviations
Tpm = Turns/metre
aTex = Twist Factor alpha Tex
TwFe = Twist Factor English
T/L = Twist Liveliness
YnStr = Single End Strength in grams
%Ext = Extension at break %
F'tn = Friction against steel

Lab Ref No. 1160

TABLE 5

Project Name - UMIST Interlock

WINCH BLEACHED	Twist factor / Tightness	3.0 / 11	3.2 / 11	3.4 / 11	3.6 / 11	3.8 / 11	3.0 / 12	3.2 / 12	3.4 / 12	3.6 / 12	3.8 / 12
	SAMPLE NO.	1	2	3	4	5	6	7	8	9	10
Length shrinkage, TD		20.25	20.78	21.11	19.19	16.91	17.42	18.64	18.42	18.38	17.99
Width shrinkage, TD		1.63	0.29	2.32	3.83	6.22	2.98	4.52	3.92	5.23	5.51
Length shrinkage, 5x		24.60	25.44	25.31	23.19	20.80	21.19	22.82	22.17	22.14	21.62
Width shrinkage, 5x		-3.20	-3.23	-4.20	1.00	3.27	2.74	2.95	2.85	4.91	4.13
Weight (gsm)BW		170.21	171.73	175.84	180.10	192.97	185.41	189.25	189.49	193.88	198.60
Weight (gsm)AW		206.39	217.47	219.48	226.61	235.62	234.85	242.45	245.05	252.97	259.80
Courses per 3cm BW		27.10	27.70	28.20	28.70	29.90	31.40	31.60	32.20	32.50	33.30
Courses per 3cm TD		33.30	33.90	34.60	34.90	35.70	38.20	38.90	39.00	39.70	40.50
Courses per 3cm AW		35.30	36.10	36.60	37.10	38.30	39.80	40.50	40.60	41.50	41.90
Wales per 3cm BW		37.30	37.00	38.10	37.30	37.90	38.20	38.20	38.20	39.10	38.80
Wales per 3cm TD		38.50	38.40	38.60	38.60	39.30	40.40	40.30	40.20	40.70	41.90
Wales per 3cm AW		36.50	36.80	36.30	37.80	39.30	40.20	40.10	40.00	40.60	41.30
Stitch length (mm) BW		4.08	4.10	4.09	4.08	4.06	3.75	3.73	3.72	3.69	3.69
Stitch length (mm) AW		4.07	4.08	4.08	4.06	4.06	3.71	3.70	3.73	3.71	3.70
Burst strength, BW		1006.30	1010.40	1048.80	1069.70	1068.30	1124.20	1162.80	1115.10	1142.20	1099.00
Burst strength, AW		925.80	946.50	983.80	943.20	963.30	1055.30	1028.10	1047.40	1076.10	1046.40
Distension at burst, BW		14.56	15.54	14.96	15.12	16.15	14.60	15.55	16.14	16.67	17.45
Distension at burst, AW		19.80	19.97	20.93	20.78	21.19	19.91	20.77	20.27	20.81	20.88
Angle of spirality, BW		-1.84	-1.88	3.62	-0.27	4.89	-4.43	-3.13	-2.99	-1.73	-0.18
Angle of spirality, AW		0.34	0.41	2.44	1.81	2.10	-1.08	-1.68	-0.07	-0.33	0.47
Yarn strength, BW		364.77	390.23	398.33	399.83	355.19	376.84	391.04	400.99	414.61	405.20
Yarn strength, AW		355.23	360.51	356.05	350.20	356.68	393.44	392.39	401.53	383.01	402.65
Yarn extension at break, BW		5.66	6.37	5.69	6.29	6.16	5.98	6.04	6.29	6.47	6.62
Yarn extension at break, AW		6.21	5.83	6.08	5.63	5.80	5.48	5.89	6.15	5.71	6.03
Yarn count (tex), BW		19.21	19.04	18.83	19.38	19.71	18.98	19.25	19.19	19.35	19.50
Yarn count (tex), AW		18.78	19.12	19.00	19.83	19.52	19.07	19.17	18.97	19.27	19.12
Thickness, BW		951.60	949.10	959.40	981.90	1005.50	958.60	953.60	958.10	970.50	998.30
Thickness, AW		1335.30	1374.20	1374.20	1420.40	1428.40	1348.80	1347.20	1332.60	1347.80	1348.70
Turns per metre		696.00	709.50	730.50	766.50	855.50	635.50	697.50	755.00	759.50	738.50

Lab Ref No. 1160

TABLE 5

Project Name - UMIST Interlock

	Twist factor	3.0	3.2	3.4	3.6	3.8	3.8	3.2	3.4	3.6	3.8
	Tightness	13	13	13	13	13	14	14	14	14	14
WINCH BLEACHED											
	SAMPLE NO.	11	12	13	14	15	16	17	18	19	20
Length shrinkage, TD		15.77	16.02	15.95	16.05	15.42	13.84	13.47	13.80	14.02	13.68
Width shrinkage, TD		6.30	7.21	7.32	7.90	9.09	8.25	9.37	9.01	9.36	10.78
Length shrinkage, 5x		18.94	19.18	19.46	19.43	18.67	16.88	16.68	16.67	16.83	15.99
Width shrinkage, 5x		5.47	6.95	6.97	6.96	8.58	8.03	9.19	8.93	9.23	10.61
Weight (gsm)BW		198.59	200.73	203.53	203.57	206.92	206.35	211.64	218.63	216.75	221.34
Weight (gsm)AW		257.07	258.68	259.71	269.27	270.55	265.67	272.49	280.41	289.27	292.80
Courses per 3cm BW		35.00	35.70	35.90	36.50	37.70	40.00	41.10	41.10	41.80	43.00
Courses per 3cm TD		41.80	42.10	42.20	43.20	44.20	46.10	47.10	47.60	48.10	49.60
Courses per 3cm AW		43.60	44.00	44.50	45.30	46.30	47.80	48.90	49.60	49.80	51.30
Wales per 3cm BW		38.80	38.80	38.60	38.60	38.90	39.60	39.50	39.20	39.50	39.20
Wales per 3cm TD		41.50	41.60	41.80	42.20	43.00	43.70	43.30	43.00	43.30	43.50
Wales per 3cm AW		40.80	40.40	40.90	41.10	42.40	43.30	43.30	43.20	43.30	43.60
Stitch length (mm) BW		3.44	3.43	3.42	3.42	3.41	3.16	3.17	3.17	3.15	3.14
Stitch length (mm) AW		3.41	3.43	3.42	3.40	3.40	3.20	3.18	3.16	3.18	3.16
Burst strength, BW		1151.30	1179.50	1218.60	1214.40	1128.20	1134.10	1225.50	1196.00	1202.40	1144.30
Burst strength, AW		1148.50	1141.90	1117.50	1136.70	1127.00	1123.70	1156.20	1180.10	1164.70	1168.00
Distension at burst, BW		14.87	15.76	16.48	15.47	17.32	14.32	15.77	15.95	16.16	16.76
Distension at burst, AW		19.55	19.94	20.29	20.44	20.58	19.49	19.78	20.00	19.47	20.19
Angle of spirality, BW		0.80	0.94	1.43	1.53	2.85	-1.56	-1.37	-1.48	-1.46	-1.23
Angle of spirality, AW		-0.28	0.46	2.24	1.90	0.85	-0.11	-0.21	-0.32	-0.31	-0.28
Yarn strength, BW		409.29	398.79	409.83	415.76	398.16	412.01	411.24	414.35	401.39	415.31
Yarn strength, AW		393.09	406.29	409.00	402.56	402.17	379.71	414.44	412.84	396.59	411.87
Yarn extension at break, BW		6.94	6.72	6.51	8.55	7.08	6.74	6.80	6.69	7.11	7.40
Yarn extension at break, AW		5.81	6.03	5.88	5.74	5.68	5.50	5.21	5.97	4.85	5.20
Yarn count (tex), BW		19.67	19.54	19.56	19.28	19.32	18.96	19.39	19.35	19.75	19.26
Yarn count (tex), AW		18.90	19.09	19.28	19.49	19.10	18.73	19.45	19.21	19.04	19.39
Thickness, BW		961.70	950.30	959.70	959.40	979.80	987.70	990.70	998.40	976.40	980.20
Thickness, AW		1295.40	1312.90	1316.70	1313.40	1336.60	1357.20	1358.30	1342.40	1336.60	1320.20
Turns per metre		749.50	763.00	789.50	846.50	902.00	781.50	743.00	772.00	801.00	861.00

Lab Ref No. 1160

TABLE 5

Project Name - UMIST Interlock

Twist factor	3.0	3.2	3.4	3.6	3.8
WINCH BLEACHED Tightness	15	15	15	15	15
SAMPLE NO.	21	22	23	24	25
Length shrinkage, TD	14.17	12.18	11.71	11.35	10.82
Width shrinkage, TD	10.73	10.82	11.08	11.32	11.57
Length shrinkage, 5x	16.35	14.23	13.63	13.05	12.85
Width shrinkage, 5x	10.16	10.13	10.58	11.01	11.53
Weight (gsm)BW	211.58	226.70	232.19	239.59	245.84
Weight (gsm)AW	274.08	286.04	288.55	297.66	299.41
Courses per 3cm BW	42.50	45.00	46.10	46.70	47.80
Courses per 3cm TD	50.00	51.60	51.90	52.70	53.70
Courses per 3cm AW	51.30	52.30	52.40	53.40	54.70
Wales per 3cm BW	40.50	40.30	39.10	39.50	39.20
Wales per 3cm TD	44.70	44.70	44.70	45.10	45.30
Wales per 3cm AW	44.50	44.30	44.40	45.10	45.10
Stitch length (mm) BW	3.04	3.02	3.02	3.03	3.00
Stitch length (mm) AW	3.03	3.02	3.02	3.02	3.01
Burst strength, BW	1247.90	1301.10	1320.80	1412.70	1283.50
Burst strength, AW	1236.50	1308.30	1299.90	1329.10	1276.10
Distension at burst, BW	13.89	15.34	16.37	16.30	17.54
Distension at burst, AW	19.13	19.69	19.60	20.43	20.72
Angle of spirality, BW	1.17	-1.44	-0.44	1.12	-0.32
Angle of spirality, AW	1.58	0.72	0.58	1.43	0.55
Yarn strength, BW	379.17	399.11	415.00	412.36	413.32
Yarn strength, AW	376.51	404.09	407.11	395.64	401.57
Yarn extension at break, BW	6.53	7.08	6.91	6.70	7.11
Yarn extension at break, AW	5.31	5.79	5.80	5.67	5.70
Yarn count (tex), BW	19.10	19.27	19.86	19.92	19.92
Yarn count (tex), AW	18.80	19.15	18.93	19.08	18.98
Thickness, BW	921.00	945.60	932.30	933.20	948.10
Thickness, AW	1195.50	1209.90	1193.60	1209.80	1222.10
Turns per metre	677.50	703.00	725.50	795.50	832.00

TABLE 6

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED. STENTER DRY

IIC Test Data :- Finished Fabric

Nominal TwF/K		Tex BW	Tex AW	TpM BW	TpM AW	aTex BW	aTex AW	TwFe BW	TwFe AW	SES BW	SES AW	%ext BW	%ext AW
3.0/11		19.21	18.78	696	675	30.5	29	3.19	3.03	364.77	355.23	5.66	6.21
3.0/12		18.98	19.07	635.5	654	27.7	28.6	2.9	2.99	376.84	393.44	5.98	5.48
3.0/13		19.67	18.9	749.5	736	33.2	32	3.47	3.34	409.29	393.09	6.94	5.81
3.0/14		18.96	18.73	701.5	675.5	30.6	29.2	3.2	3.05	412.01	379.71	6.74	5.5
3.0/15		19.1	18.8	677.5	682	29.6	29.6	3.09	3.09	379.17	376.51	6.53	5.31
	mean	19.18	18.86	692	684.5	30.32	29.68	3.17	3.1	388.42	379.59	6.37	5.66
	sd	0.29	0.14	41.28	30.66	1.99	1.35	0.21	0.14	21.04	15.63	0.54	0.36
3.2/11		19.04	19.12	709.5	709	31.5	30.9	3.29	3.23	390.23	360.51	6.37	5.83
3.2/12		19.25	19.17	697.5	661.5	30.6	28.9	3.2	3.02	391.04	392.39	6.04	5.89
3.2/13		19.54	19.09	763	742	33.7	32.4	3.52	3.39	398.79	406.29	6.72	6.03
3.2/14		19.39	19.45	743	704.5	32.7	30.9	3.42	3.23	411.24	414.44	6.8	5.21
3.2/15		19.27	19.15	703	705	31.1	30.9	3.25	3.23	399.11	404.09	7.08	5.79
	mean	19.3	19.2	723.2	704.4	31.92	30.8	3.34	3.22	398.08	395.54	6.6	5.75
	sd	0.18	0.15	28.43	28.62	1.26	1.24	0.13	0.13	8.46	21.11	0.41	0.31
3.4/11		18.83	19	730.5	720	31.7	31.4	3.31	3.28	398.33	356.05	5.69	6.08
3.4/12		19.19	18.97	755	714	33.1	31.1	3.46	3.25	400.99	401.53	6.29	6.15
3.4/13		19.56	19.28	789.5	773.5	34.9	34	3.65	3.55	409.83	409	6.51	5.88
3.4/14		19.35	19.21	772	751	34	32.9	3.55	3.44	414.35	412.84	6.69	5.97
3.4/15		19.86	18.93	725.5	733.5	32.3	31.9	3.38	3.33	415	407.11	6.91	5.8
	mean	19.36	19.08	754.5	738.4	33.2	32.26	3.47	3.37	407.7	397.31	6.42	5.98
	sd	0.39	0.16	27.15	24.23	1.28	1.19	0.13	0.12	7.66	23.42	0.47	0.15
3.6/11		19.38	19.83	766.5	797.5	33.7	35.3	3.52	3.69	399.83	350.2	6.29	5.63
3.6/12		19.35	19.27	759.5	776	34.1	34	3.56	3.55	414.61	383.01	6.47	5.71
3.6/13		19.28	19.49	846.5	824.5	37.2	36.4	3.89	3.8	415.76	402.56	8.55	5.74
3.6/14		19.75	19.04	801	773	35.6	33.7	3.72	3.52	401.39	396.59	7.11	4.85
3.6/15		19.92	19.08	795.5	782.5	35.5	34.2	3.71	3.57	412.36	395.64	6.7	5.67
	mean	19.54	19.34	793.8	790.7	35.22	34.72	3.68	3.63	408.79	385.6	7.02	5.52
	sd	0.28	0.32	34.47	21.13	1.39	1.12	0.15	0.12	7.59	21.03	0.91	0.38
3.8/11		19.71	19.52	855.5	900.5	37.9	39.5	3.96	4.13	355.19	356.68	6.16	5.8
3.8/12		19.5	19.12	738.5	843.5	32.6	36.9	3.41	3.86	405.2	402.65	6.62	6.03
3.8/13		19.32	19.1	902	911.5	39.7	39.9	4.15	4.17	390.16	402.17	7.08	5.68
3.8/14		19.26	19.39	861	851	37.8	37.5	3.95	3.92	415.31	411.87	7.4	5.2
3.8/15		19.92	18.98	832	833.5	37.1	36.3	3.88	3.79	413.32	401.57	7.11	5.7
	mean	19.54	19.22	837.8	868	37.02	38.02	3.87	3.97	395.83	394.99	6.88	5.68
	sd	0.27	0.22	60.97	35.45	2.65	1.6	0.28	0.17	24.78	21.83	0.49	0.3

TABLE 7

UMIST FABRICS : IIC TEST DATA

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED. STENTER DRY

STUDENTS T STATISTIC for 24 DEGREES OF FREEDOM
Significance Level : 95% = 2.064
99% = 2.797
99.9% = 3.745

COMPARISON YARN DATA BEFORE/AFTER RELAXATION

	Mean Difference	t	r sq
Tex	-0.245	3.2409 **	0.0136
Turns/metre	-3.06	0.483	0.8158
alpha Tex	-0.44	1.5496	0.8194
Twist Factor	-0.046	1.5496	0.8194
S.E.S	-9.1571	2.6942 *	0.3641
% Extension	-0.9383	5.9179 ***	0.1399

TABLE 8

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED. STENTER DRY

IIC Test Data :- Finished Fabric

Nominal TwF/K		TpM BW	TpM AW	AvTpM BW/AW	aTex BW	aTex AW	Avatex BW/AW	TwFe BW	TwFe AW	AvTwFe BW/AW
3.0/11		696	675	685.5	30.5	29	29.75	3.19	3.03	3.11
3.0/12		635.5	654	644.75	27.7	28.6	28.15	2.9	2.99	2.94
3.0/13		749.5	736	742.75	33.2	32	32.6	3.47	3.34	3.41
3.0/14		701.5	675.5	688.5	30.6	29.2	29.9	3.2	3.05	3.13
3.0/15		677.5	682	679.75	29.6	29.6	29.6	3.09	3.09	3.09
	mean	692	684.5	688.25	30.32	29.68	30	3.17	3.1	3.14
	sd	41.28	30.66	35.15	1.99	1.35	1.61	0.21	0.14	0.17
3.2/11		709.5	709	709.25	31.5	30.9	31.2	3.29	3.23	3.26
3.2/12		697.5	661.5	679.5	30.6	28.9	29.75	3.2	3.02	3.11
3.2/13		763	742	752.5	33.7	32.4	33.05	3.52	3.39	3.45
3.2/14		743	704.5	723.75	32.7	30.9	31.8	3.42	3.23	3.32
3.2/15		703	705	704	31.1	30.9	31	3.25	3.23	3.24
	mean	723.2	704.4	713.8	31.92	30.8	31.36	3.34	3.22	3.28
	sd	28.43	28.62	26.88	1.26	1.24	1.2	0.13	0.13	0.13
3.4/11		730.5	720	725.25	31.7	31.4	31.55	3.31	3.28	3.3
3.4/12		755	714	734.5	33.1	31.1	32.1	3.46	3.25	3.36
3.4/13		789.5	773.5	781.5	34.9	34	34.45	3.65	3.55	3.6
3.4/14		772	751	761.5	34	32.9	33.45	3.55	3.44	3.5
3.4/15		725.5	733.5	729.5	32.3	31.9	32.1	3.38	3.33	3.36
	mean	754.5	738.4	746.45	33.2	32.26	32.73	3.47	3.37	3.42
	sd	27.15	24.23	24.16	1.28	1.19	1.19	0.13	0.12	0.12
3.6/11		766.5	797.5	782	33.7	35.3	34.5	3.52	3.69	3.61
3.6/12		759.5	776	767.75	34.1	34	34.05	3.56	3.55	3.56
3.6/13		846.5	824.5	835.5	37.2	36.4	36.8	3.89	3.8	3.85
3.6/14		801	773	787	35.6	33.7	34.65	3.72	3.52	3.62
3.6/15		795.5	782.5	789	35.5	34.2	34.85	3.71	3.57	3.64
	mean	793.8	790.7	792.25	35.22	34.72	34.97	3.68	3.63	3.66
	sd	34.47	21.13	25.56	1.39	1.12	1.06	0.15	0.12	0.11
3.8/11		855.5	900.5	878	37.9	39.5	38.7	3.96	4.13	4.05
3.8/12		738.5	843.5	791	32.6	36.9	34.75	3.41	3.86	3.63
3.8/13		902	911.5	906.75	39.7	39.9	39.8	4.15	4.17	4.16
3.8/14		861	851	856	37.8	37.5	37.65	3.95	3.92	3.94
3.8/15		832	833.5	832.75	37.1	36.3	36.7	3.88	3.79	3.84
	mean	837.8	868	852.9	37.02	38.02	37.52	3.87	3.97	3.92
	sd	60.97	35.45	44.09	2.65	1.6	1.93	0.28	0.17	0.2

TABLE 9

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED, STENTER DRY

IIC TEST DATA :- Finished Reference State

Nominal Tightness	TwF3.0 Tex	TwF3.2 Tex	TwF3.4 Tex	TwF3.6 Tex	TwF3.8 Tex
11	18.78	19.12	19	19.83	19.52
12	19.07	19.17	18.97	19.27	19.12
13	18.9	19.09	19.28	19.49	19.1
14	18.73	19.45	19.21	19.04	19.39
15	18.8	19.15	18.93	19.08	18.98

*** COLUMN STATISTICS ***

			N	Mean	SD	CV%
1.	TwF3.0	Tex	5	18.8560	0.1346	0.71
2.	TwF3.2	Tex	5	19.1960	0.1452	0.76
3.	TwF3.4	Tex	5	19.0780	0.1564	0.82
4.	TwF3.6	Tex	5	19.3420	0.3260	1.69
5.	TwF3.8	Tex	5	19.2220	0.2241	1.17

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC :- WINCH BLEACHED. STENTER DRY

IIC Test Data :- Finished Reference State

Nominal Tightness	avSLcm	TwF3.0	TwF3.2	TwF3.4	TwF3.6	TwF3.8
Courses/cm						
15	0.302	17.1	17.43	17.47	17.8	18.23
14	0.3175	15.93	16.3	16.53	16.6	17.1
13	0.3412	14.53	14.67	14.83	15.1	15.43
12	0.3709	13.27	13.5	13.53	13.83	13.97
11	0.4069	11.77	12.03	12.2	12.37	12.77
Wales/cm						
15	0.302	14.83	14.77	14.8	15.03	15.03
14	0.3175	14.43	14.43	14.4	14.43	14.53
13	0.3412	13.6	13.47	13.63	13.7	14.13
12	0.3709	13.4	13.37	13.33	13.53	13.77
11	0.4069	12.17	12.27	12.1	12.6	13.1
Weight gsm						
15	0.302	274.08	286.04	288.55	297.66	299.41
14	0.3175	265.67	272.49	280.41	289.27	292.8
13	0.3412	257.07	258.68	259.71	269.27	270.55
12	0.3709	234.85	242.44	245.05	252.97	259.88
11	0.4069	206.39	217.47	219.48	226.6	235.62
Stitches/sqcm						
15	0.302	253.65	257.43	258.51	267.59	274.11
14	0.3175	229.97	235.26	238.08	239.59	248.52
13	0.3412	197.65	197.51	202.23	206.87	218.12
12	0.3709	177.77	180.45	180.44	187.21	192.27
11	0.4069	143.16	147.61	147.62	155.82	167.24

TABLE 11

UMIST FABRICS : IIC TEST DATA

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED, STENTER DRY

STUDENTS T STATISTIC for 4 DEGREES OF FREEDOM
Significance Level : 95% = 2.776 *
99% = 4.604 **
99.9% = 8.610 ***

COMPARISON : COURSES/CM FINISHED REFERENCE STATE

Nominal Twist Factor		3.2	3.4	3.6	3.8
3.0	Mean Dif	0.2667	0.3933	0.62	0.98
	T	5.8424 **	5.9561 **	20.4779 ***	10.3461 ***
	r sq	0.9986	0.9964	0.9997	0.9953
3.2	Mean Dif	n.a.	0.1267	0.3533	0.7133
	T	n.a.	2.8324 *	13.9789 ***	10.1446 ***
	r sq	n.a.	0.9983	0.9995	0.997
3.4	Mean Dif	n.a.	n.a.	0.2267	0.5867
	T	n.a.	n.a.	4.1576 **	9.8387 ***
	r sq	n.a.	n.a.	0.9975	0.9984
3.6	Mean Dif	n.a.	n.a.	n.a.	0.36
	T	n.a.	n.a.	n.a.	5.1341 **
	r sq	n.a.	n.a.	n.a.	0.997

TABLE 12

UMIST FABRICS : IIC TEST DATA

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED, STENTER DRY

STUDENTS T STATISTIC for 4 DEGREES OF FREEDOM
Significance Level : 95% = 2.776 *
99% = 4.604 **
99.9% = 8.610 ***

COMPARISON : WALES/CM FINISHED REFERENCE STATE

Nominal Twist Factor		3.2	3.4	3.6	3.8
	Mean Dif	-0.0267	-0.0333	0.0511	0.4267
3.0	T	0.6181	1.633	2.1363	2.6033
	r sq	0.9949	0.9986	0.9847	0.9748
	Mean Dif	n.a.	-0.0067	0.2	0.4533
3.2	T	n.a.	0.1101	3.1514 *	3.0544 *
	r sq	n.a.	0.9895	0.9864	0.9645
	Mean Dif	n.a.	n.a.	0.2067	0.46
3.4	T	n.a.	n.a.	2.238	2.7368
	r sq	n.a.	n.a.	0.9803	0.9788
	Mean Dif	n.a.	n.a.	n.a.	0.2533
3.6	T	n.a.	n.a.	n.a.	2.3797
	r sq	n.a.	n.a.	n.a.	0.9858

TABLE 13

UMIST FABRICS : IIC TEST DATA

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED, STENTER DRY

STUDENTS T STATISTIC for 4 DEGREES OF FREEDOM
Significance Level : 95% = 2.776 *
99% = 4.604 **
99.9% = 8.610 ***

COMPARISON : WEIGHT gsm FINISHED REFERENCE STATE

Nominal Twist Factor		3.2		3.4		3.6		3.8	
3.0	Mean Dif	7.8116		11.0254		19.543		24.0371	
	T	3.805	*	4.3909	*	8.2783	**	7.8321	**
	r sq	0.9775		0.9673		0.9738		0.9503	
3.2	Mean Dif	n.a.		3.2138		11.7314		16.2255	
	T	n.a.		2.379		7.9303	**	9.269	***
	r sq	n.a.		0.9918		0.9933		0.9835	
3.4	Mean Dif	n.a.		n.a.		8.5176		13.0117	
	T	n.a.		n.a.		17.3849	***	10.881	***
	r sq	n.a.		n.a.		0.9996		0.9977	
3.6	Mean Dif	n.a.		n.a.		n.a.		4.4941	
	T	n.a.		n.a.		n.a.		2.6768	
	r sq	n.a.		n.a.		n.a.		0.9955	

TABLE 14

UMIST FABRICS : IIC TEST DATA

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED, STENTER DRY

STUDENTS T STATISTIC for 4 DEGREES OF FREEDOM
Significance Level : 95% = 2.776 *
99% = 4.604 **
99.9% = 8.610 ***

COMPARISON : STITCHES sqcm FINISHED REFERENCE STATE

Nominal Twist Factor		3.2	3.4	3.6	3.8
3.0	Mean Dif	3.2113	4.934	10.9758	19.6122
	T	3.0518 *	5.003 **	10.0903 ***	11.2429 ***
	r sq	0.9977	0.9985	0.9976	0.9936
3.2	Mean Dif	n.a.	1.7227	7.7644	16.4009
	T	n.a.	1.6965	6.7314 **	8.5332 **
	r sq	n.a.	0.9981	0.9972	0.9925
3.4	Mean Dif	n.a.	n.a.	6.0418	14.6782
	T	n.a.	n.a.	3.9773 *	8.0751 **
	r sq	n.a.	n.a.	0.9954	0.9944
3.6	Mean Dif	n.a.	n.a.	n.a.	8.6364
	T	n.a.	n.a.	n.a.	6.1093 **
	r sq	n.a.	n.a.	n.a.	0.9963

TABLE 15

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC :- WINCH BLEACHED, STENTER DRY

IIC Test Data :- Finished Fabric

Nominal TwF/K	1W+TD LS%	1W+TD WS%	5W+TD LS%	5W+TD WS%
3.0/11	20.25	1.63	24.6	-3.2
3.2/11	20.78	0.29	25.44	-3.23
3.4/11	21.11	2.32	25.31	-4.2
3.6/11	19.19	3.83	23.19	1
3.8/11	16.91	6.22	20.8	3.27
3.0/12	17.42	2.98	21.19	2.74
3.2/12	18.64	4.52	22.82	2.95
3.4/12	18.42	3.92	22.17	2.85
3.6/12	18.38	5.23	22.14	4.91
3.8/12	17.99	5.51	21.62	4.13
3.0/13	15.77	6.3	18.94	5.47
3.2/13	16.02	7.21	19.18	6.95
3.4/13	15.95	7.32	19.46	6.97
3.6/13	16.05	7.9	19.43	6.96
3.8/13	15.42	9.09	18.67	8.58
3.0/14	13.84	8.25	16.88	8.03
3.2/14	13.47	9.37	16.68	9.19
3.4/14	13.8	9.01	16.67	8.93
3.6/14	14.02	9.36	16.83	9.23
3.8/14	13.68	10.78	15.99	10.61
3.0/15	14.17	10.73	16.35	10.16
3.2/15	12.18	10.82	14.23	10.13
3.4/15	11.71	11.08	13.63	10.58
3.6/15	11.35	11.32	13.05	11.01
3.8/15	10.82	11.57	12.85	11.53

TABLE 16

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC :- WINCH BLEACHED, STENTER DRY

IIC Test Data :- Finished Fabric

Nominal TwF/K	1W+TD LS%	1W+TD WS%	5W+TD LS%	5W+TD WS%
3.0/15	14.17	10.73	16.35	10.16
3.0/14	13.84	8.25	16.88	8.03
3.0/13	15.77	6.3	18.94	5.47
3.0/12	17.42	2.98	21.19	2.74
3.0/11	20.25	1.63	24.6	-3.2
3.2/15	12.18	10.82	14.23	10.13
3.2/14	13.47	9.37	16.68	9.19
3.2/13	16.02	7.21	19.18	6.95
3.2/12	18.64	4.52	22.82	2.95
3.2/11	20.78	0.29	25.44	-3.23
3.4/15	11.71	11.08	13.63	10.58
3.4/14	13.8	9.01	16.67	8.93
3.4/13	15.95	7.32	19.46	6.97
3.4/12	18.42	3.92	22.17	2.85
3.4/11	21.11	2.32	25.31	-4.2
3.6/15	11.35	11.32	13.05	11.01
3.6/14	14.02	9.36	16.83	9.23
3.6/13	16.05	7.9	19.43	6.96
3.6/12	18.38	5.23	22.14	4.91
3.6/11	19.19	3.83	23.19	1
3.8/15	10.82	11.57	12.85	11.53
3.8/14	13.68	10.78	15.99	10.61
3.8/13	15.42	9.09	18.67	8.58
3.8/12	17.99	5.51	21.62	4.13
3.8/11	16.91	6.22	20.8	3.27

TABLE 17

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED. STENTER DRY

COEFFICIENTS of the STARFISH MODEL equations. and
for the individual data sets 28 Gauge and 20 Gauge

	a	b	c
COURSES/CM			
STARFISH	-10.023	6.675	1.321
28G WB	-10.489	6.5403	1.647
20G WB/WBT	-5.4309	5.6965	0.8771
WALES/CM			
STARFISH	15.861	2.447	-2.205
28G WB	15.6299	2.167	-1.768
20 G WB/WBT	15.9247	2.1661	-2.0113
WEIGHT GSM			
STARFISH	7.206	4.595	n.a.
28G WB	6.5739	4.6056	n.a.
20G WB/WBT	43.0271	3.8011	n.a.
STITCHES/SQCM			
STARFISH	63.287	22.037	-2.659
28G WB	84.9004	21.3505	-3.7612
20G WB/WBT	90.1804	19.1694	-2.9316

TABLE 18

UMIST FABRICS : IIC TEST DATA

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED, STENTER DRY

REGRESSION ANALYSIS
MODEL : Y = A + BX

Nominal Twist Factor	a	b	r sq
COURSES/cm = a + b * 1/avSL			
3.0	-3.3829	6.1541	0.9981
3.2	-3.4576	6.2715	0.9952
3.4	-3.274	6.2519	0.9959
3.6	-3.1512	6.2876	0.997
3.8	-3.3665	6.4854	0.9939
WALES/cm = a + b * 1/avSL			
3.0	5.0932	2.954	0.9584
3.2	5.4866	2.8096	0.9528
3.4	4.9135	3.0043	0.9652
3.6	6.1433	2.6526	0.9639
3.8	7.8966	2.137	0.9874
WEIGHT gsm = a + b * avTex/avSL			
3.0	21.1959	4.1268	0.9544
3.2	29.8297	4.039	0.9907
3.4	23.9	4.2291	0.9894
3.6	25.6089	4.2933	0.9894
3.8	54.6633	3.8808	0.983
STITCHES sqcm = a + b * 1/avSL^2			
3.0	13.6456	21.8305	0.9936
3.2	15.94	21.9377	0.9899
3.4	14.0744	22.357	0.9952
3.6	22.9889	22.0213	0.9924
3.8	35.4751	21.5714	0.998

UMIST FABRICS

TABLE 19

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED, STENTER DRY

IIC Test Data

Nominal K/TwF	AvTpM BW/AW	AvaTex BW/AW	TpM Yarn	aTex Yarn	T/L Yarn	C/cm AW	W/cm AW	Wtgsm AW	Ssqcm AW
11/3.0	688.25	30	728	31.5	52.1	11.77	12.17	206.39	143.16
11/3.2	713.8	31.36	734	33.2	60.1	12.03	12.27	217.47	147.61
11/3.4	746.45	32.73	770.4	33.7	61.9	12.2	12.1	219.48	147.62
11/3.6	792.25	34.97	820.5	36.8	62.4	12.37	12.6	226.6	155.82
11/3.8	852.9	37.52	809.1	36.7	68	12.77	13.1	235.62	167.24
12/3.0	688.25	30	728	31.5	52.1	13.27	13.4	234.85	177.77
12/3.2	713.8	31.36	734	33.2	60.1	13.5	13.37	242.44	180.45
12/3.4	746.45	32.73	770.4	33.7	61.9	13.53	13.33	245.05	180.44
12/3.6	792.25	34.97	820.5	36.8	62.4	13.83	13.53	252.97	187.21
12/3.8	852.9	37.52	809.1	36.7	68	13.97	13.77	259.88	192.27
13/3.0	688.25	30	728	31.5	52.1	14.53	13.6	257.07	197.65
13/3.2	713.8	31.36	734	33.2	60.1	14.67	13.47	258.68	197.51
13/3.4	746.45	32.73	770.4	33.7	61.9	14.83	13.63	259.71	202.23
13/3.6	792.25	34.97	820.5	36.8	62.4	15.1	13.7	269.27	206.87
13/3.8	852.9	37.52	809.1	36.7	68	15.43	14.13	270.55	218.12
14/3.0	688.25	30	728	31.5	52.1	15.93	14.43	265.67	229.97
14/3.2	713.8	31.36	734	33.2	60.1	16.3	14.43	272.49	235.26
14/3.4	746.45	32.73	770.4	33.7	61.9	16.53	14.4	280.41	238.08
14/3.6	792.25	34.97	820.5	36.8	62.4	16.6	14.43	289.27	239.59
14/3.8	852.9	37.52	809.1	36.7	68	17.1	14.53	292.8	248.52
15/3.0	688.25	30	728	31.5	52.1	17.1	14.83	274.08	253.65
15/3.2	713.8	31.36	734	33.2	60.1	17.43	14.77	286.04	257.43
15/3.4	746.45	32.73	770.4	33.7	61.9	17.47	14.8	288.55	258.51
15/3.6	792.25	34.97	820.5	36.8	62.4	17.8	15.03	297.66	267.59
15/3.8	852.9	37.52	809.1	36.7	68	18.23	15.03	299.41	274.11

1)AvTpM = Turns per metre measured in yarn extracted from fabric averaged over stitch length and before and after relaxation
2)AvaTex = Alpha Tex twist factor calculated from individual measurements of TpM and Tex then averaged over stitch length and before and after relaxation.
3)T/L = Twist Liveliness of the grey yarn measured from the cone.

TABLE 20

UMIST FABRICS : IIC TEST DATA

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED. STENTER DRY

REGRESSION ANALYSIS
MODEL : Y = A + BX

Nominal Tightness K	a	b	r sq
COURSES/cm = a + b * average Turns/metre			
11	7.931	0.0057	0.979
12	10.468	0.0042	0.9461
13	10.746	0.0055	0.9996
14	11.693	0.0063	0.9367
15	12.703	0.0065	0.9717
WALES/cm = a + b * average Turns/metre			
11	8.073	0.0058	0.8355
12	11.65	0.0024	0.7923
13	11.086	0.0035	0.7967
14	14.011	6.0E-4	0.5515
15	13.611	0.0017	0.7239
WEIGHT gsm = a + b * average Turns/metre			
11	98.356	0.1618	0.9475
12	136.381	0.1458	0.9749
13	193.37	0.0918	0.8981
14	153.502	0.1669	0.9324
15	180.17	0.1436	0.852
STITCHES sqcm = a + b * average Turns/metre			
11	44.316	0.1423	0.9553
12	115.908	0.0893	0.9603
13	107.605	0.1277	0.9558
14	161.568	0.1011	0.9478
15	166.387	0.1264	0.9755

TABLE 21

UMIST FABRICS : IIC TEST DATA

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED. STENTER DRY

REGRESSION ANALYSIS
MODEL : Y = A + BX

Nominal Tightness K	a	b	r sq
COURSES/cm = a + b * average Twist Factor (alpha Tex)			
11	8.087	0.1243	0.9795
12	10.56	0.0918	0.9605
13	10.901	0.1204	0.9982
14	11.868	0.1388	0.9366
15	12.872	0.1421	0.9755
WALES/cm = a + b * average Twist Factor (alpha Tex)			
11	8.247	0.126	0.8295
12	11.732	0.0525	0.7784
13	11.226	0.0745	0.7691
14	14.035	0.0124	0.5322
15	13.656	0.0371	0.7267
WEIGHT gsm = a + b * average Twist Factor (alpha Tex)			
11	102.214	3.5688	0.9575
12	139.929	3.215	0.9838
13	195.503	2.0277	0.9091
14	157.335	3.6858	0.9445
15	182.765	3.1931	0.8746
STITCHES sqcm = a + b * average Twist Factor (alpha Tex)			
11	48.463	3.1165	0.9515
12	118.288	1.9613	0.9629
13	111.854	2.7801	0.9413
14	164.497	2.2148	0.9445
15	169.709	2.7779	0.9792

TABLE 22

UMIST FABRICS : IIC TEST DATA

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED, STENTER DRY

REGRESSION ANALYSIS
MODEL : Y = A + BX

Nominal Tightness K	a	b	r sq
COURSES/cm = a + b * average Twist Liveliness (from cone)			
11	8.427	0.0624	0.9144
12	10.893	0.0448	0.8457
13	11.477	0.0564	0.8114
14	12.06	0.0728	0.9537
15	13.355	0.0698	0.8718
WALES/cm = a + b * average Twist Liveliness (from cone)			
11	9.151	0.0541	0.5664
12	12.203	0.021	0.4608
13	11.822	0.0309	0.4919
14	14.134	0.0051	0.34
15	14.089	0.0132	0.3402
WEIGHT gsm = a + b * average Twist Liveliness (from cone)			
11	109.223	1.8372	0.9398
12	150.415	1.5866	0.8873
13	209.748	0.8754	0.6274
14	170.429	1.8013	0.8355
15	187.408	1.6706	0.8865
STITCHES sqcm = a + b * average Twist Liveliness (from cone)			
11	64.055	1.4489	0.7616
12	129.247	0.893	0.7393
13	128.73	1.2438	0.6977
14	168.942	1.1386	0.9245
15	184.598	1.2752	0.7642

TABLE 23

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC :- WINCH BLEACHED. STENTER DRY

IIC TEST DATA : FINISHED FABRIC REFERENCE STATE

Nominal TwF/K	avSLcm	1/avSL	1/aSL^	avTex	RavTex	aT/aSL	ToM	Tpcm	Tpl	aTex	C/cm	W/cm	Wtgsm	Ssqcm
3.0/15	0.302	3.3113	10.9644	18.86	4.34	62.45	688.25	6.8825	2.0785	30	17.1	14.83	274.08	253.65
3.0/14	0.3175	3.1496	9.92	18.86	4.34	59.4	688.25	6.8825	2.1852	30	15.93	14.43	265.67	229.97
3.0/13	0.3412	2.9308	8.5898	18.86	4.34	55.28	688.25	6.8825	2.3483	30	14.53	13.6	257.07	197.65
3.0/12	0.3709	2.6961	7.2692	18.86	4.34	50.85	688.25	6.8825	2.5527	30	13.27	13.4	234.85	177.77
3.0/11	0.4069	2.4576	6.0398	18.86	4.34	46.35	688.25	6.8825	2.8005	30	11.77	12.17	206.39	143.16
3.2/15	0.302	3.3113	10.9644	19.2	4.38	63.58	713.8	7.138	2.1557	31.36	17.43	14.77	286.04	257.43
3.2/14	0.3175	3.1496	9.92	19.2	4.38	60.47	713.8	7.138	2.2663	31.36	16.3	14.43	272.49	235.26
3.2/13	0.3412	2.9308	8.5898	19.2	4.38	56.27	713.8	7.138	2.4355	31.36	14.67	13.47	258.68	197.51
3.2/12	0.3709	2.6961	7.2692	19.2	4.38	51.77	713.8	7.138	2.6475	31.36	13.5	13.37	242.44	180.45
3.2/11	0.4069	2.4576	6.0398	19.2	4.38	47.19	713.8	7.138	2.9045	31.36	12.03	12.27	217.47	147.61
3.4/15	0.302	3.3113	10.9644	19.08	4.37	63.18	746.45	7.4645	2.2543	32.73	17.47	14.8	288.55	258.51
3.4/14	0.3175	3.1496	9.92	19.08	4.37	60.09	746.45	7.4645	2.37	32.73	16.53	14.4	280.41	238.08
3.4/13	0.3412	2.9308	8.5898	19.08	4.37	55.92	746.45	7.4645	2.5469	32.73	14.83	13.63	259.71	202.23
3.4/12	0.3709	2.6961	7.2692	19.08	4.37	51.44	746.45	7.4645	2.7686	32.73	13.53	13.33	245.05	180.44
3.4/11	0.4069	2.4576	6.0398	19.08	4.37	46.89	746.45	7.4645	3.0373	32.73	12.2	12.1	219.48	147.62
3.6/15	0.302	3.3113	10.9644	19.34	4.4	64.04	792.25	7.9225	2.3926	34.97	17.8	15.03	297.66	267.59
3.6/14	0.3175	3.1496	9.92	19.34	4.4	60.91	792.25	7.9225	2.5154	34.97	16.6	14.43	289.27	239.59
3.6/13	0.3412	2.9308	8.5898	19.34	4.4	56.68	792.25	7.9225	2.7032	34.97	15.1	13.7	269.27	206.87
3.6/12	0.3709	2.6961	7.2692	19.34	4.4	52.14	792.25	7.9225	2.9385	34.97	13.83	13.53	252.97	187.21
3.6/11	0.4069	2.4576	6.0398	19.34	4.4	47.53	792.25	7.9225	3.2237	34.97	12.37	12.6	226.6	155.82
3.8/15	0.302	3.3113	10.9644	19.22	4.38	63.64	852.9	8.529	2.5758	37.52	18.23	15.03	299.41	274.11
3.8/14	0.3175	3.1496	9.92	19.22	4.38	60.54	852.9	8.529	2.708	37.52	17.1	14.53	292.8	248.52
3.8/13	0.3412	2.9308	8.5898	19.22	4.38	56.33	852.9	8.529	2.9101	37.52	15.43	14.13	270.55	218.12
3.8/12	0.3709	2.6961	7.2692	19.22	4.38	51.82	852.9	8.529	3.1634	37.52	13.97	13.77	259.88	192.27
3.8/11	0.4069	2.4576	6.0398	19.22	4.38	47.24	852.9	8.529	3.4705	37.52	12.77	13.1	235.62	167.24

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED. STENTER DRY

REGRESSION ANALYSIS

	a	b	c	rso
MODEL Y = A + BX				
COURSES	-3.3264	6.2901	n.a.	0.9672
WALES	5.9066	2.7115	n.a.	0.9117
STITCHES	20.4248	21.9436	n.a.	0.9632
WEIGHT	27.2384	4.1821	n.a.	0.9085
MODEL Y = A + B(X1) + C(X2)				
COURSES	-59.77	6.2901	12.9007	0.9822
WALES	-14.13	2.7115	4.5789	0.9212
STITCHES	-510.39	21.9436	27.7331	0.9762

TABLE 25

UMIST FABRICS

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED. STENTER DRY

REGRESSION ANALYSIS

	a	b	c	rso
MODEL Y = A + B(X1) + C(X2) (X2 = turns per cm)				
COURSES	-7.5903	6.2901	0.562	0.9954
WALES	3.7983	2.7115	0.2779	0.9466
STITCHES	-68.61	21.9436	11.7343	0.9934
WEIGHT	-59.93	4.1177	11.9614	0.9818
MODEL Y = A + B(X1) + C(X2) (X2 = turns per loop)				
COURSES	-11.95	7.7904	1.615	0.996
WALES	1.6289	3.4556	0.801	0.9477
STITCHES	-111.57	27.2169	32.9301	0.9932
WEIGHT	-130.55	5.5838	30.2293	0.9758
MODEL Y = A + B(X1) + C(X2) (X2 = alphatex)				
COURSES	-7.4408	6.2901	0.1235	0.9954
WALES	3.8912	2.7115	0.0605	0.9461
STITCHES	-65.2	21.9436	2.5701	0.9932
WEIGHT	-56.62	4.1152	2.6288	0.982

UMIST FABRICS

TABLE 26

20 GAUGE INTERLOCK : NOMINAL Ne 1/30
FINISHED FABRIC : WINCH BLEACHED. STENTER DRY

REGRESSION ANALYSIS

MODEL Y = A + B(X1) + C(X2) + D(X3)

	a	b	c	d	rsq
COURSES	-15.213	6.2901	1.8096	0.52	0.9955
WALES	13.9042	2.7115	-2.399	0.33	0.9481
STITCHES	-45.097	21.944	-1.3266	11.98	0.9934

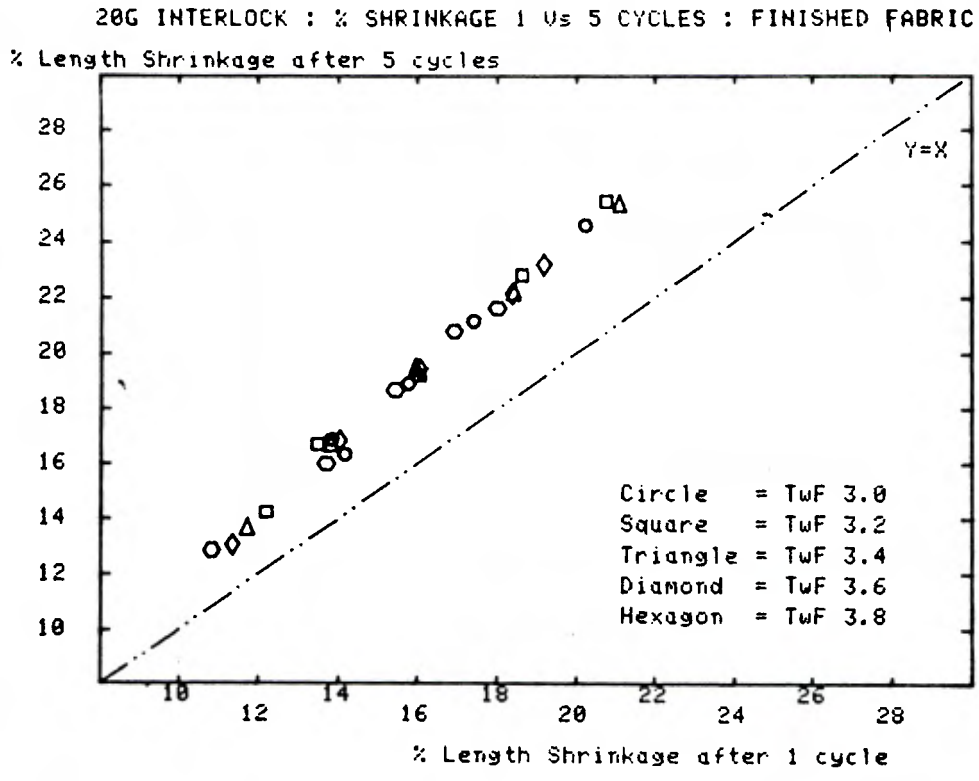


FIGURE 1

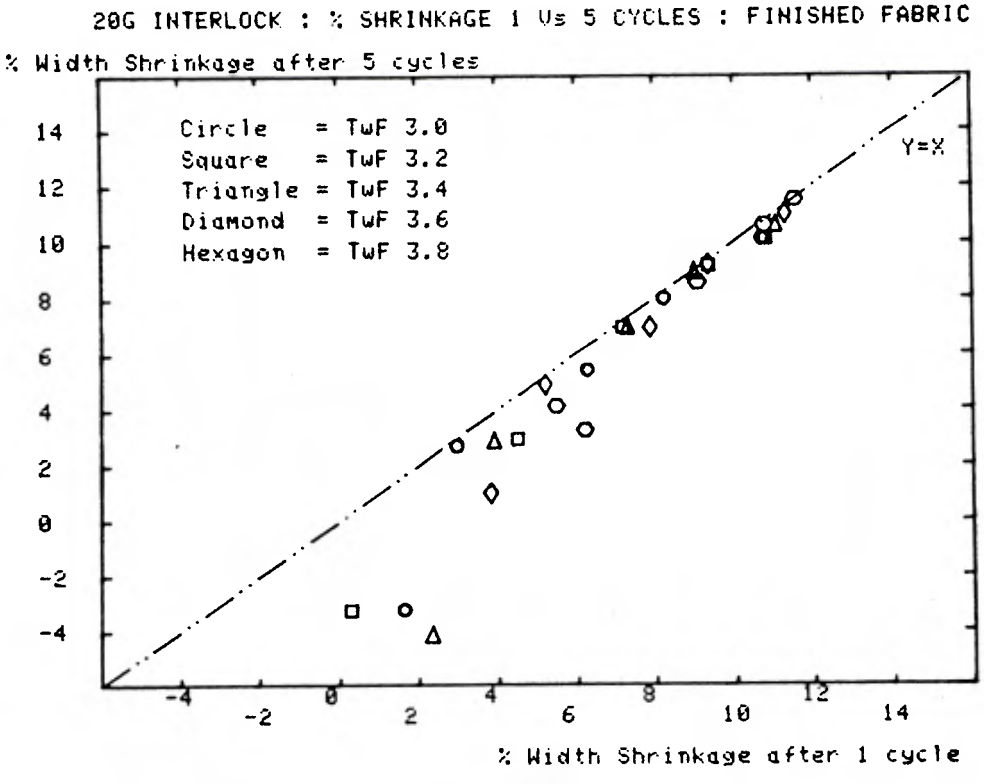


FIGURE 2

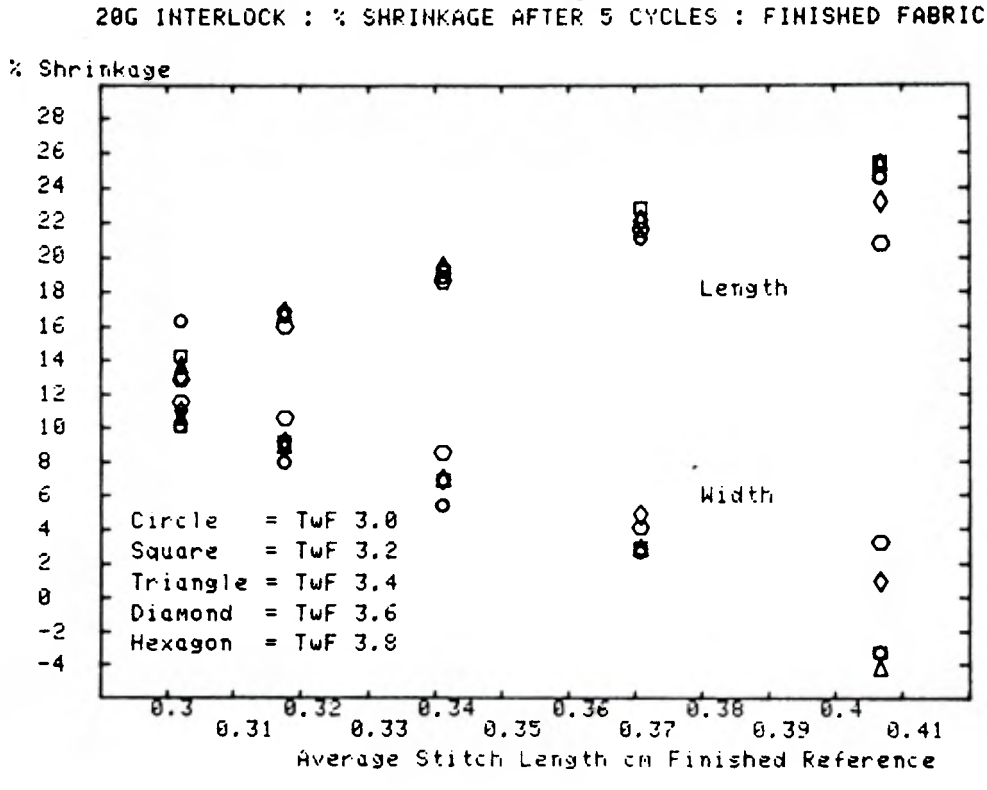

20G INTERLOCK : % SHRINKAGE AFTER 5 CYCLES : FINISHED FABRIC
% Shrinkage
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
Length
Width
Circle = TwF 3.0
Square = TwF 3.2
Triangle = TwF 3.4
Diamond = TwF 3.6
Hexagon = TwF 3.8
0.3
0.31
0.32
0.33
0.34
0.35
0.36
0.37
0.38
0.39
0.4
0.41
Average Stitch Length cm Finished Reference

FIGURE 3

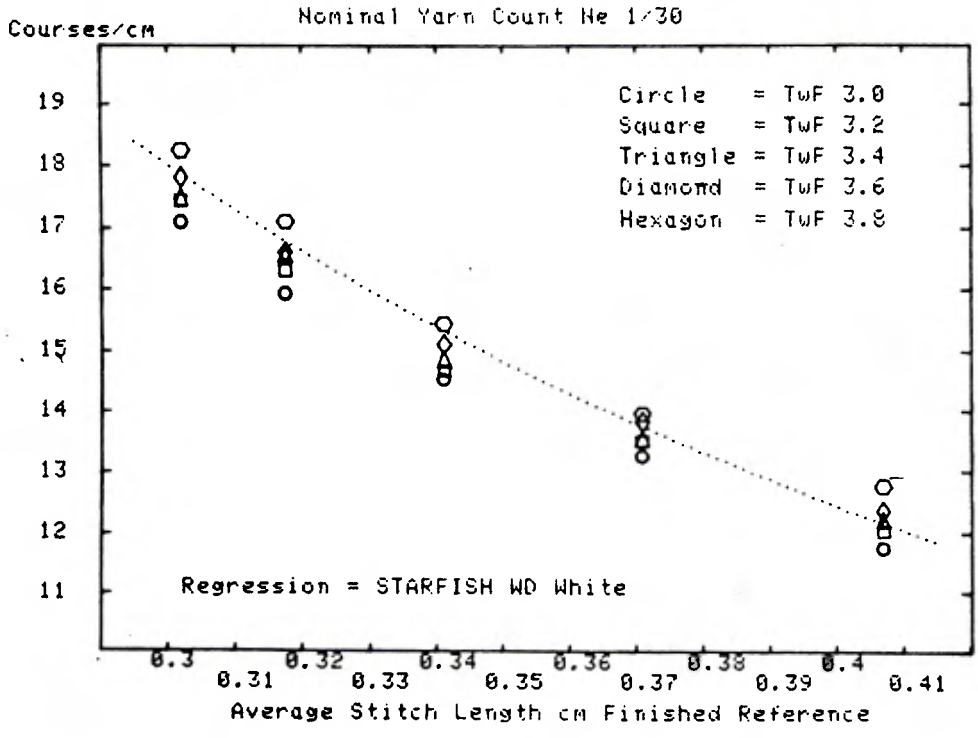


FIGURE 4

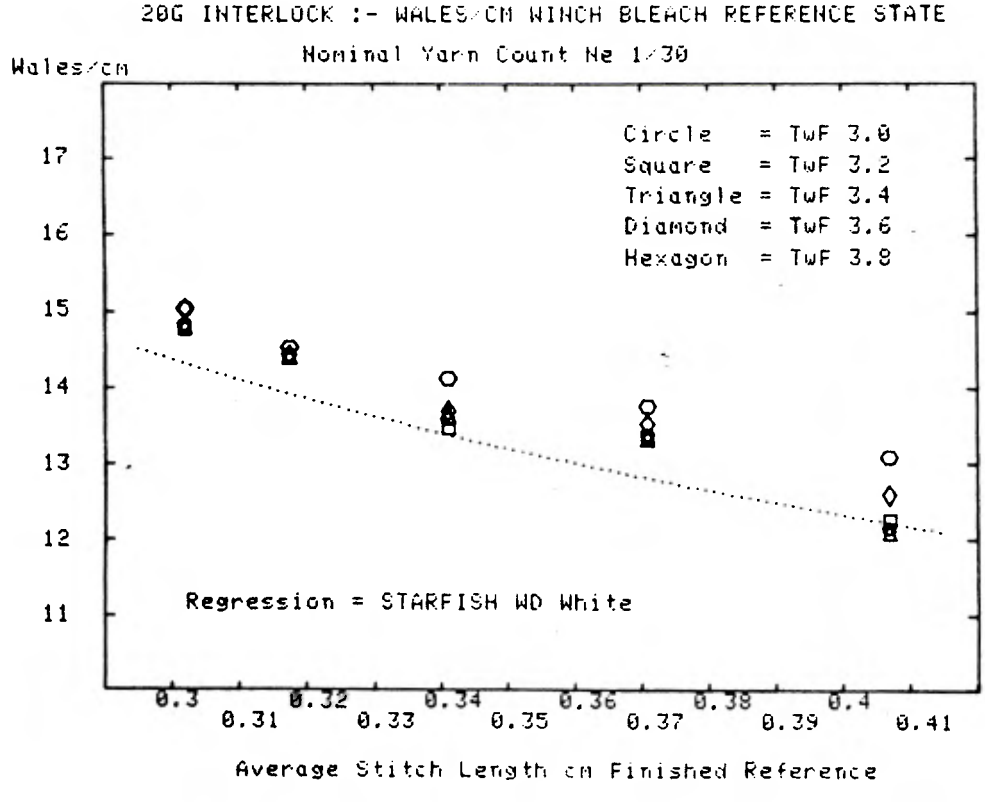


FIGURE 5

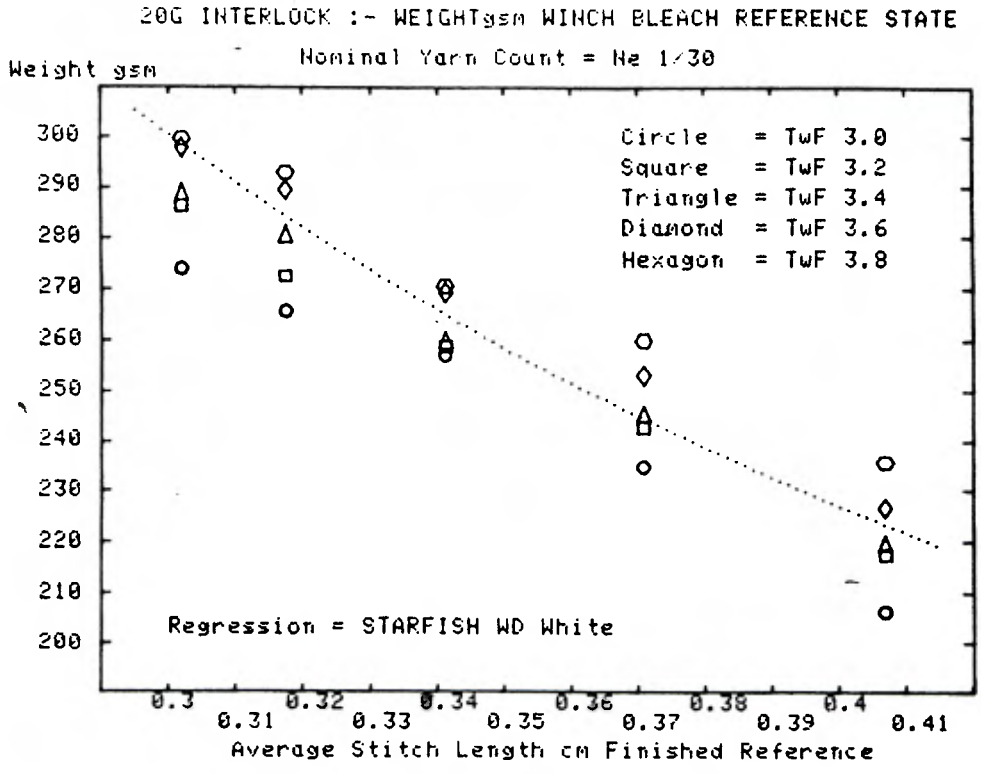


FIGURE 6

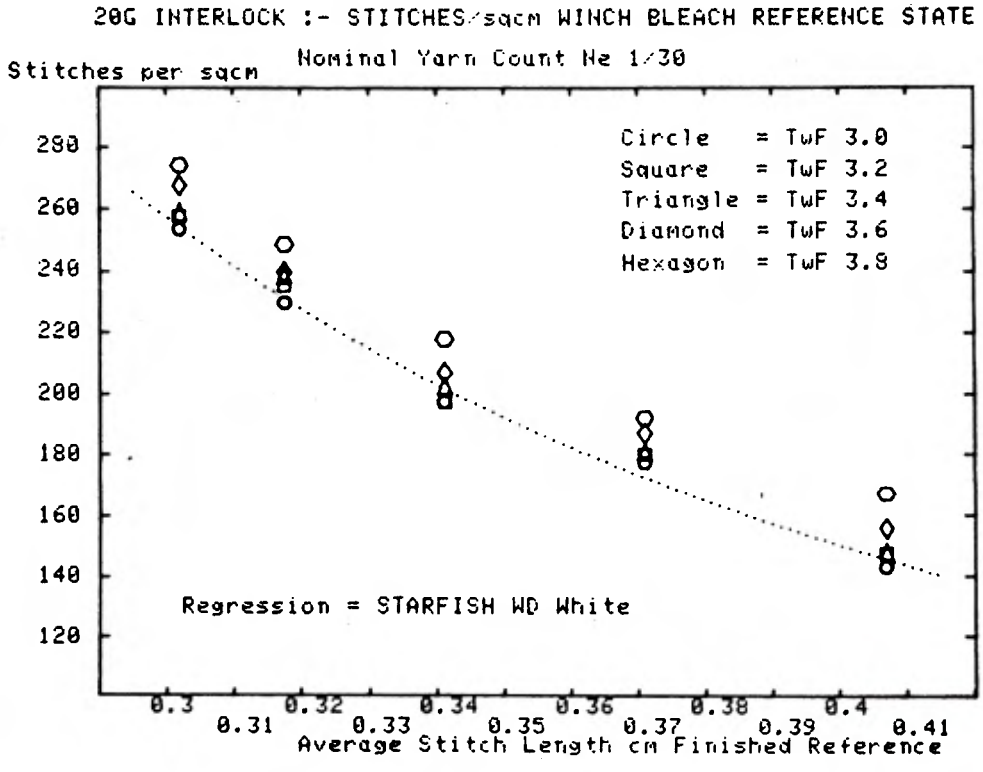


FIGURE 7

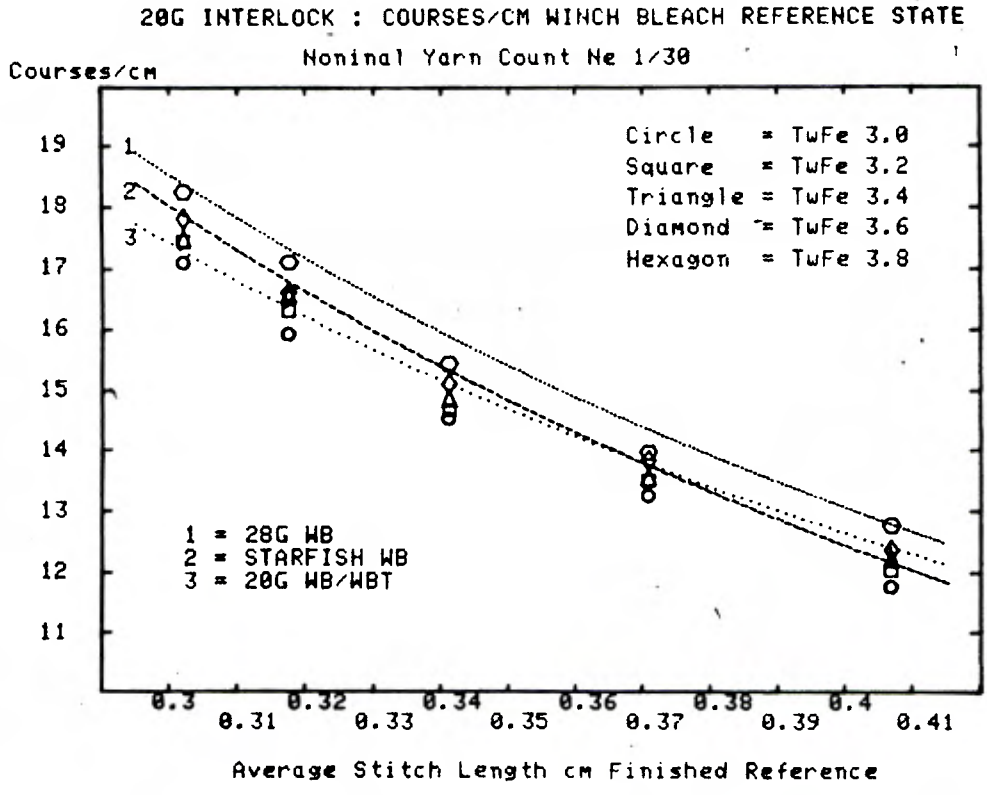


FIGURE 8

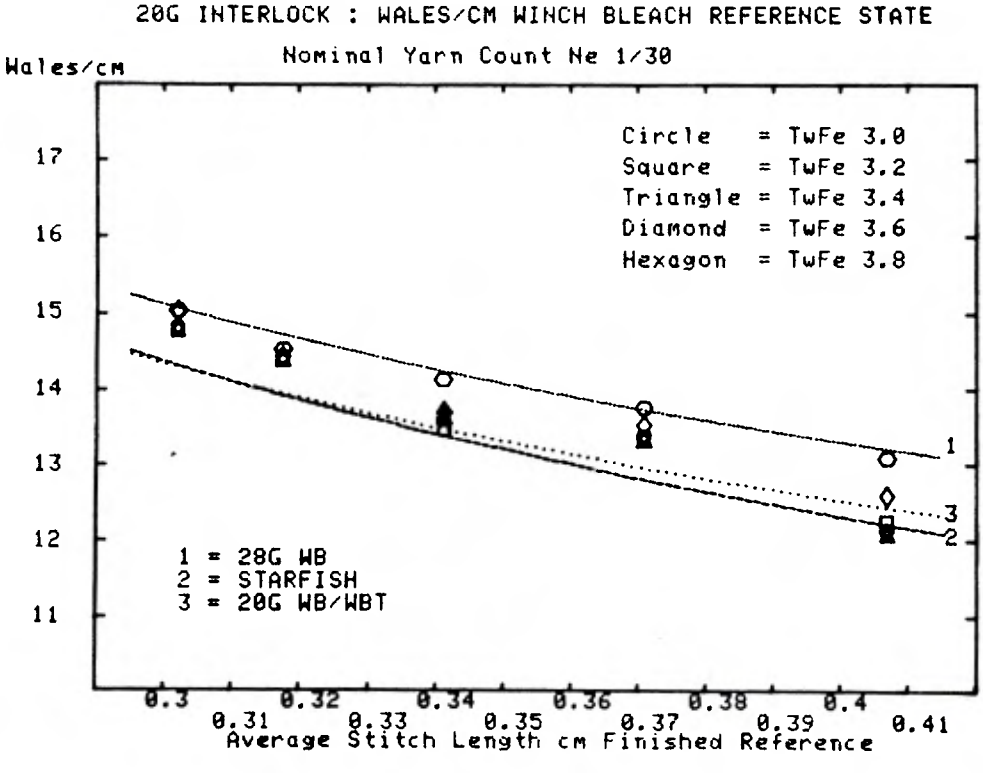


FIGURE 9

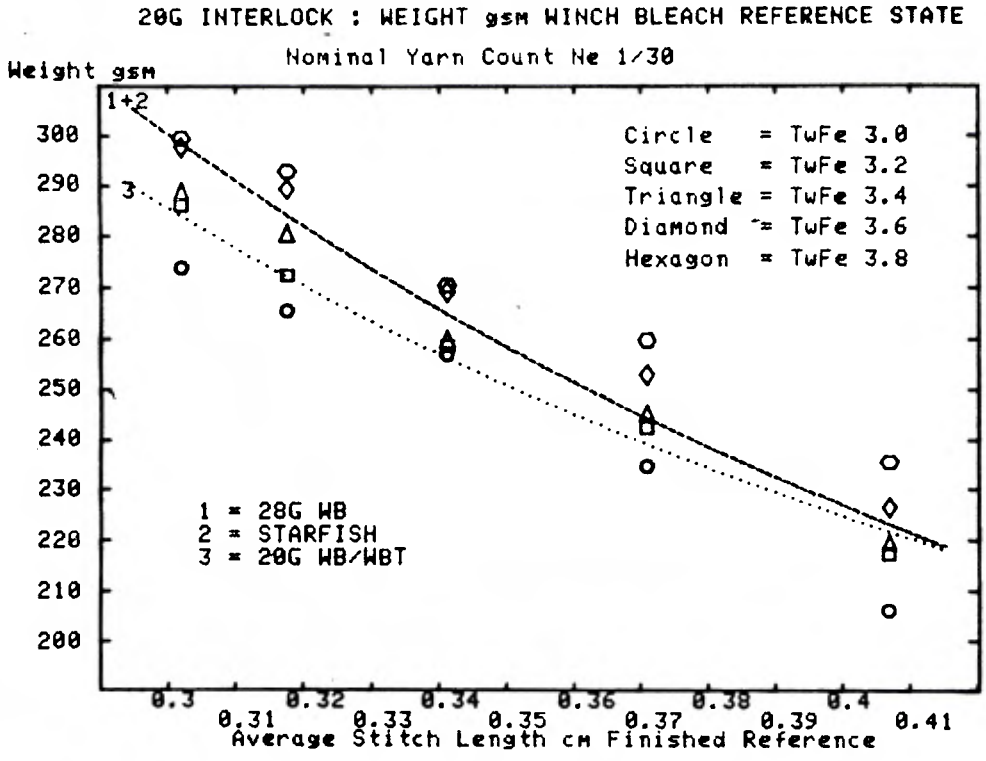


FIGURE 10

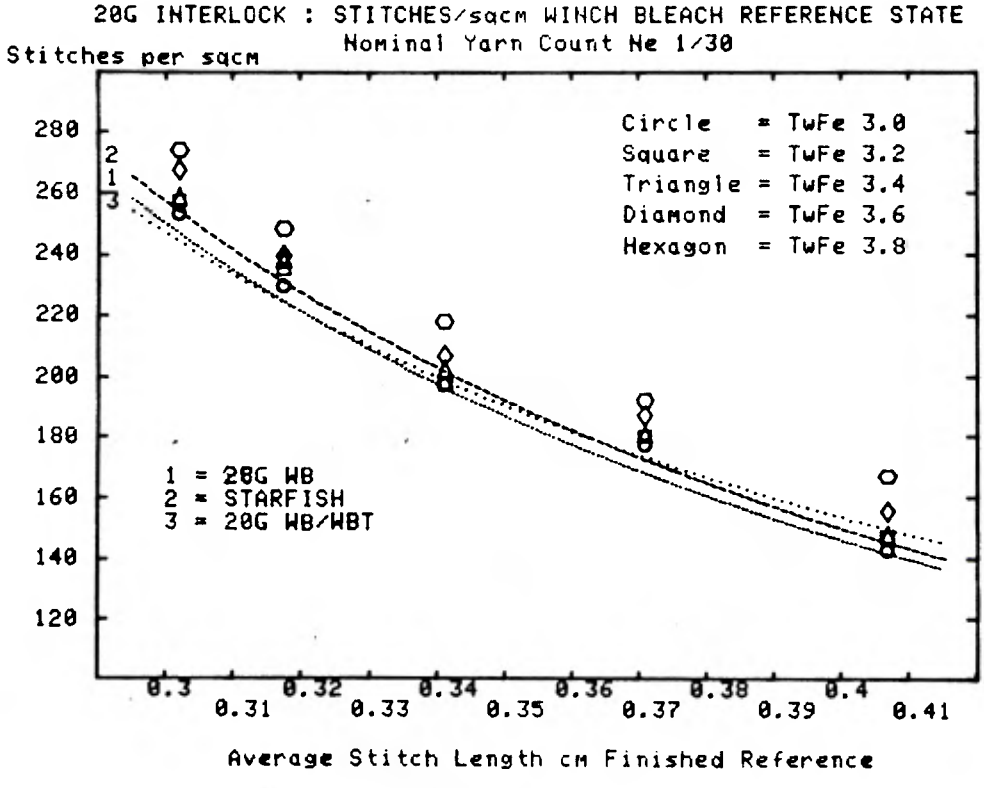
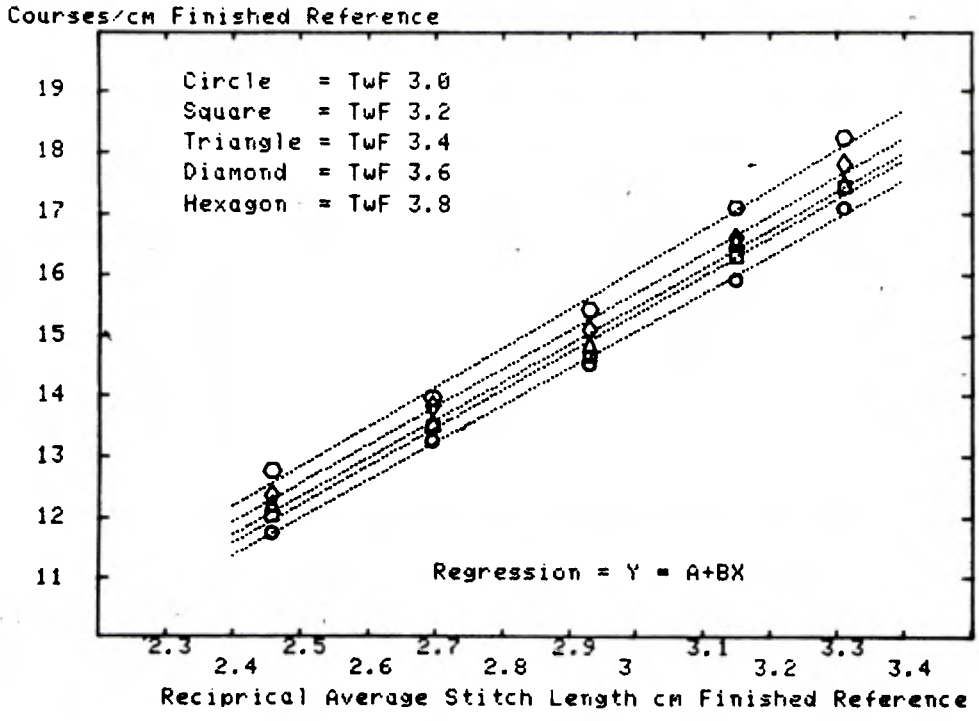


FIGURE 11

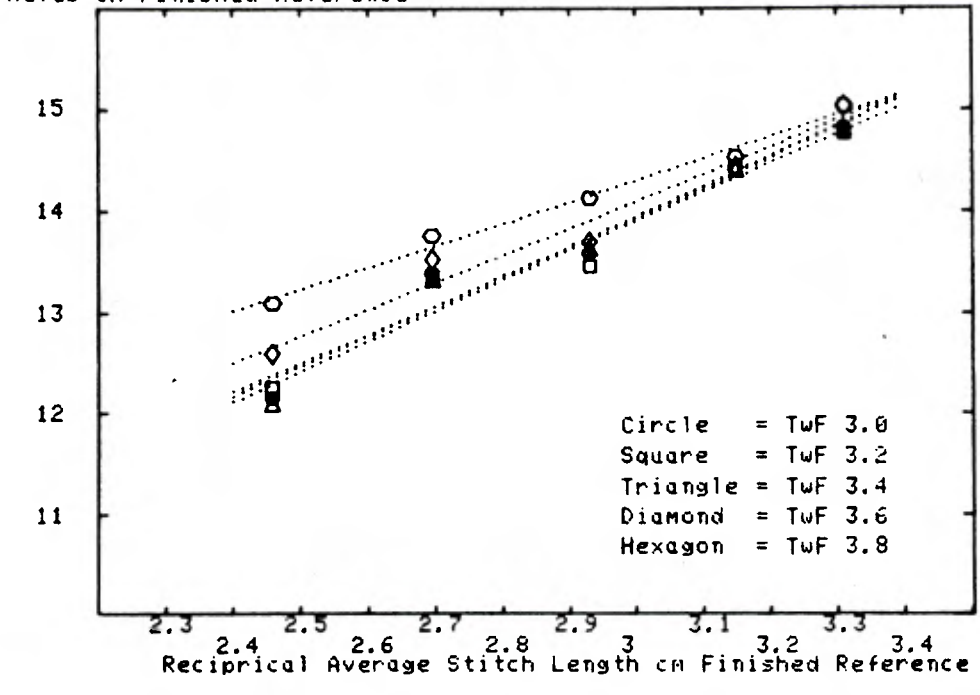
20G INTERLOCK :- EFFECT OF YARN TWIST ON FINISHED REFERENCE COURSES

FIGURE 12



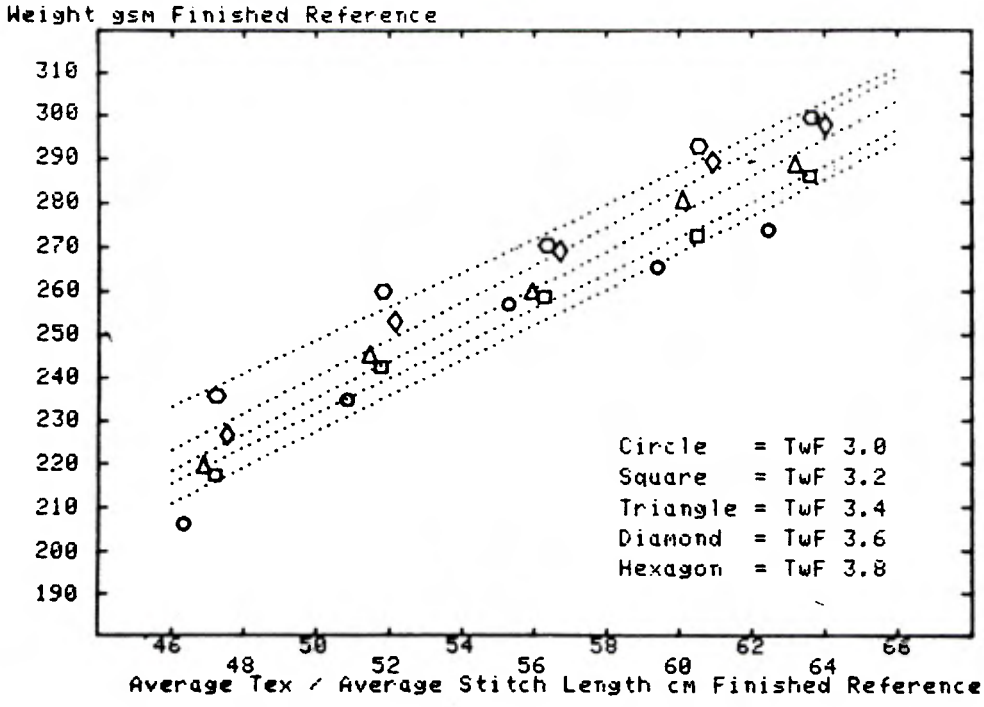
20G INTERLOCK :- EFFECT OF YARN TWIST ON FINISHED REFERENCE WALES

FIGURE 13



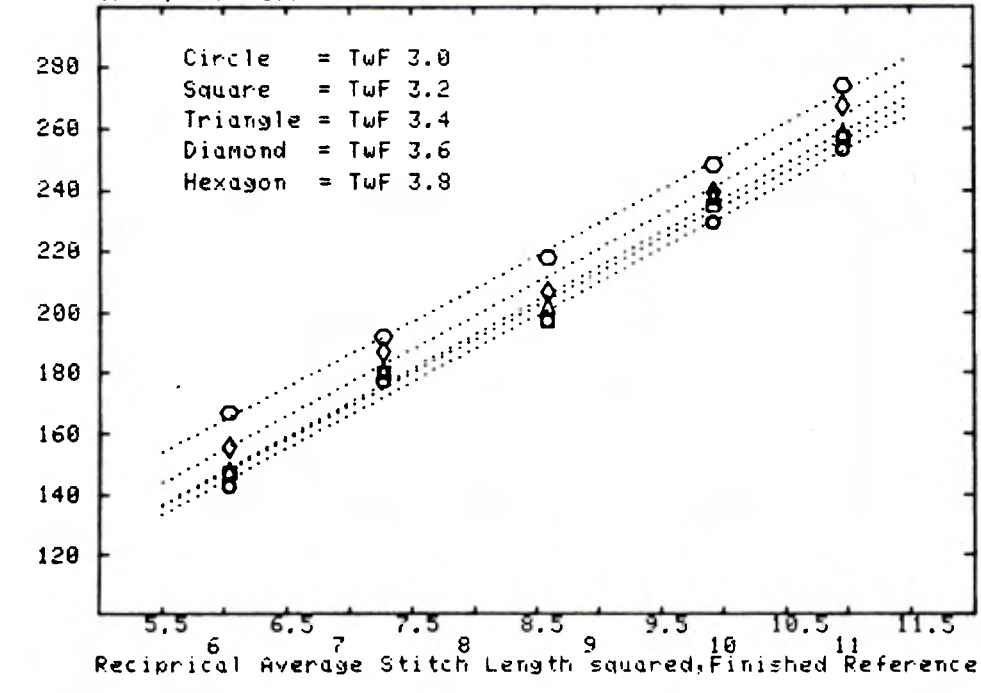
20G INTERLOCK :- EFFECT OF YARN TWIST ON FINISHED REFERENCE WEIGHT

FIGURE 14



20G INTERLOCK :- EFFECT OF YARN TWIST ON FINISHED REFERENCE STITCHES

FIGURE 15



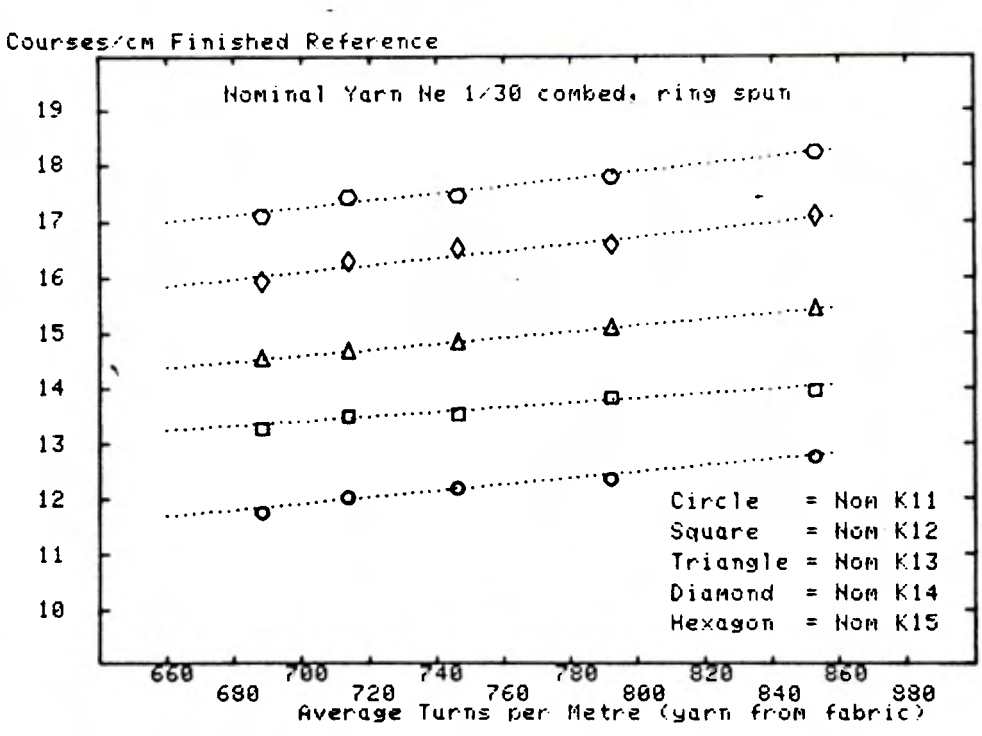


FIGURE 16

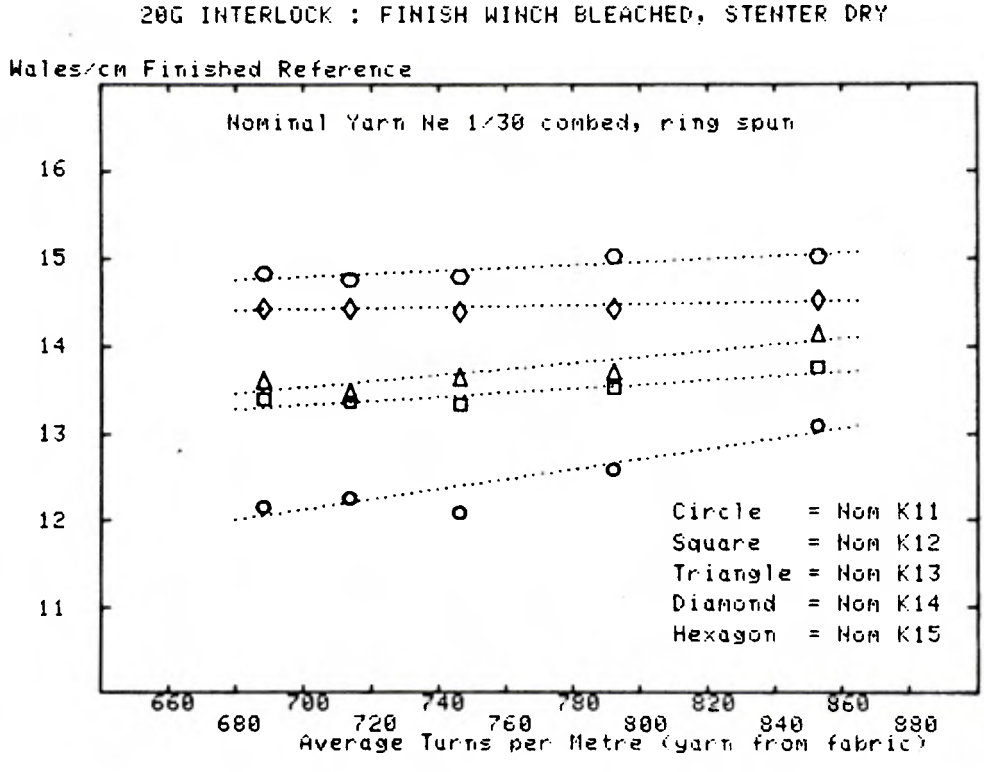


FIGURE 17

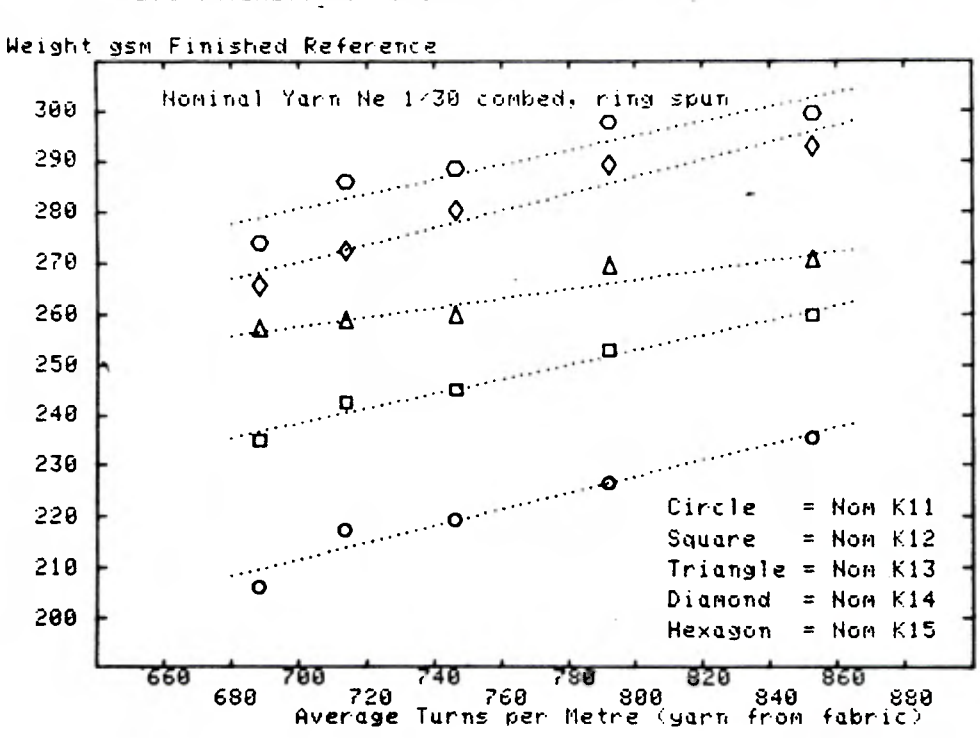


FIGURE 18

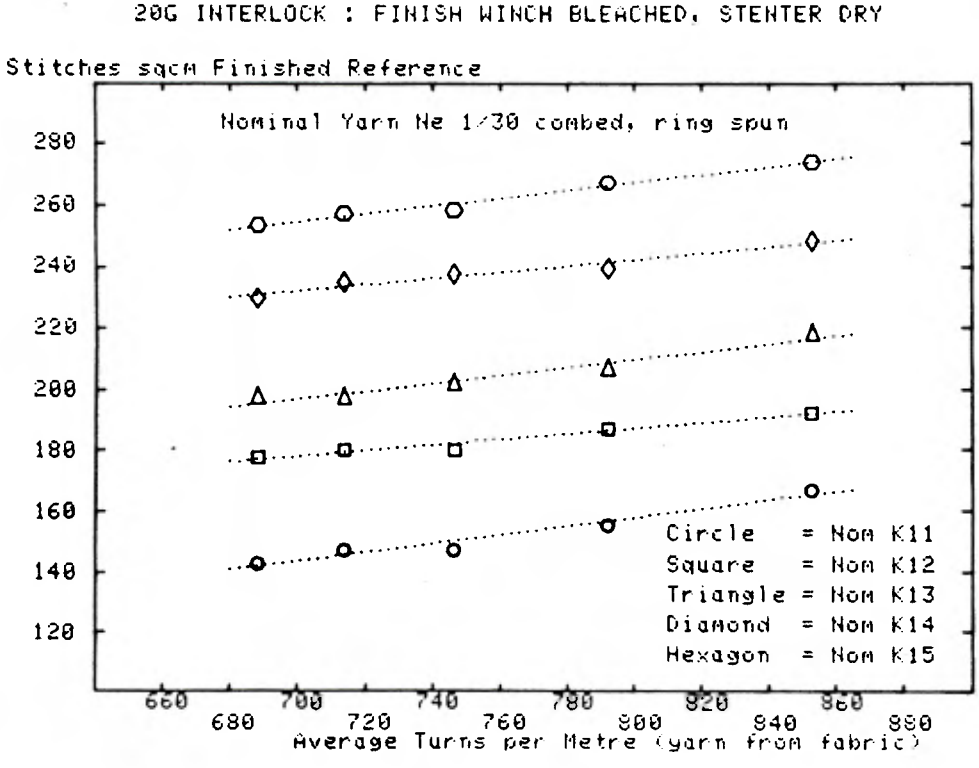
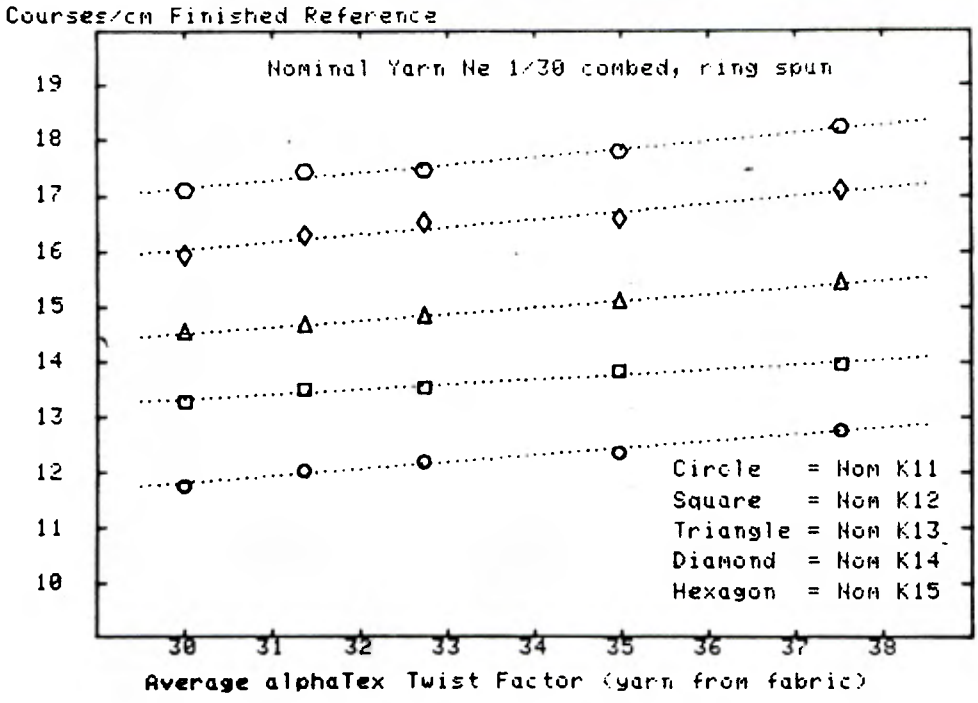


FIGURE 19

20G INTERLOCK : FINISH WINCH BLEACHED, STENTER DRY

FIGURE 20



20G INTERLOCK : FINISH WINCH BLEACHED, STENTER DRY

FIGURE 21

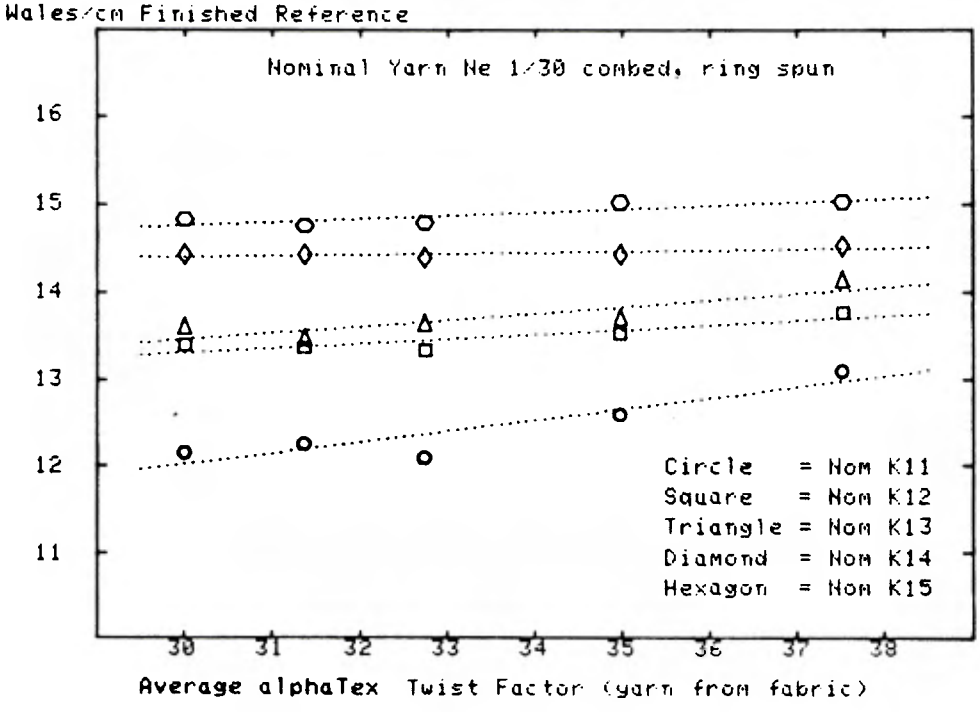


FIGURE 22

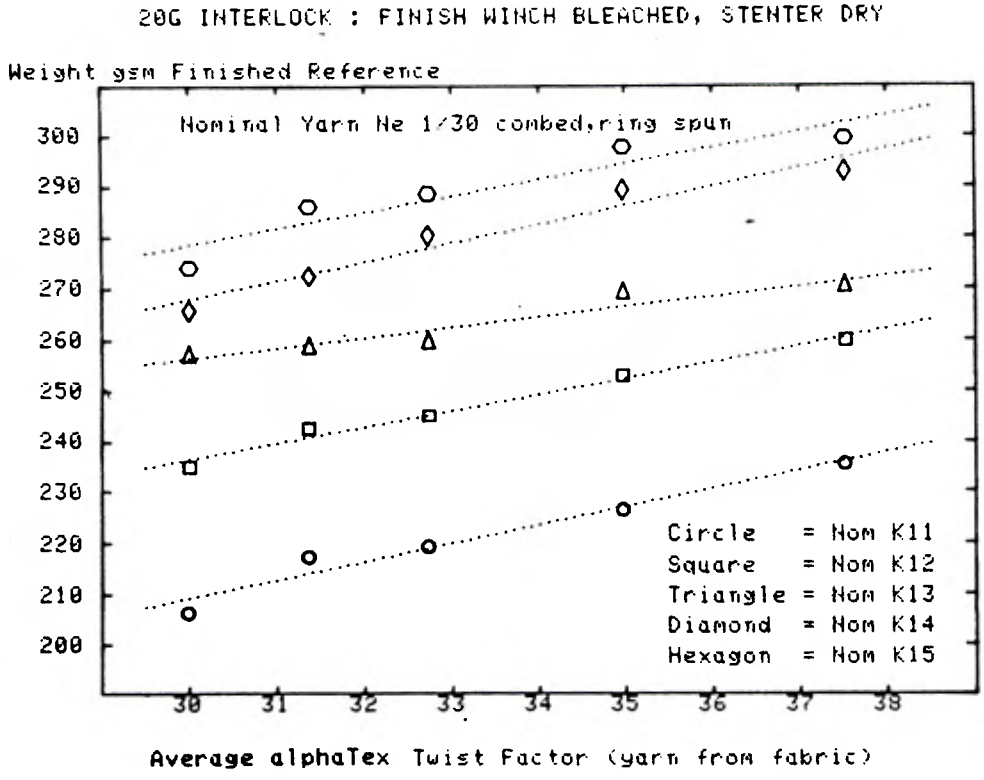
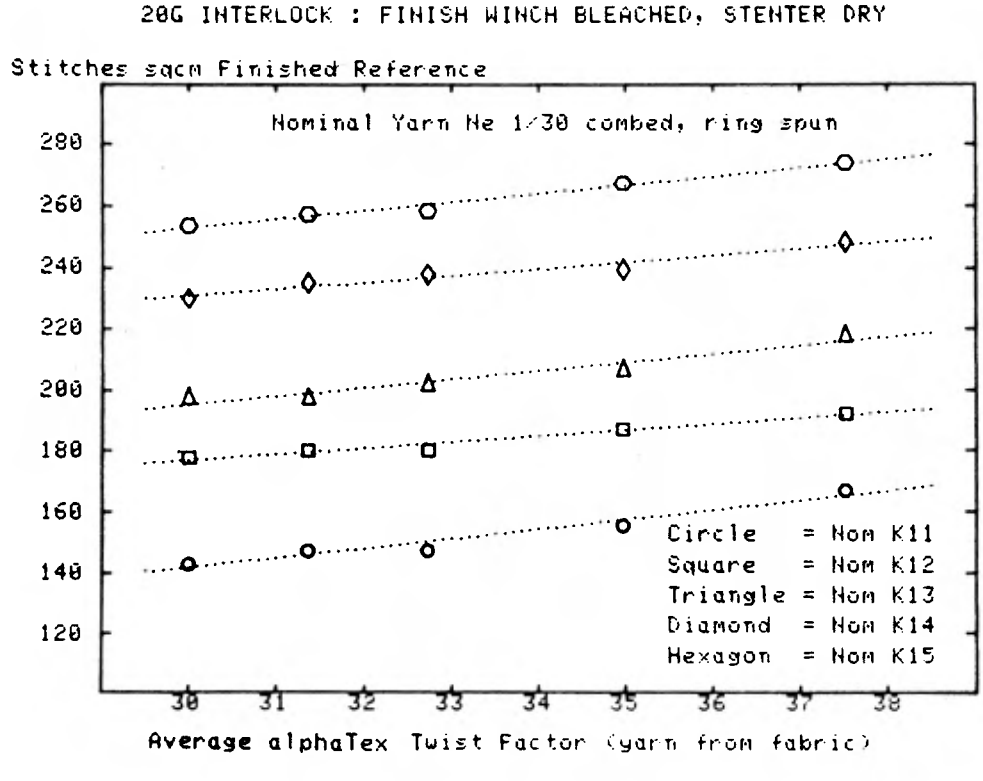


FIGURE 23



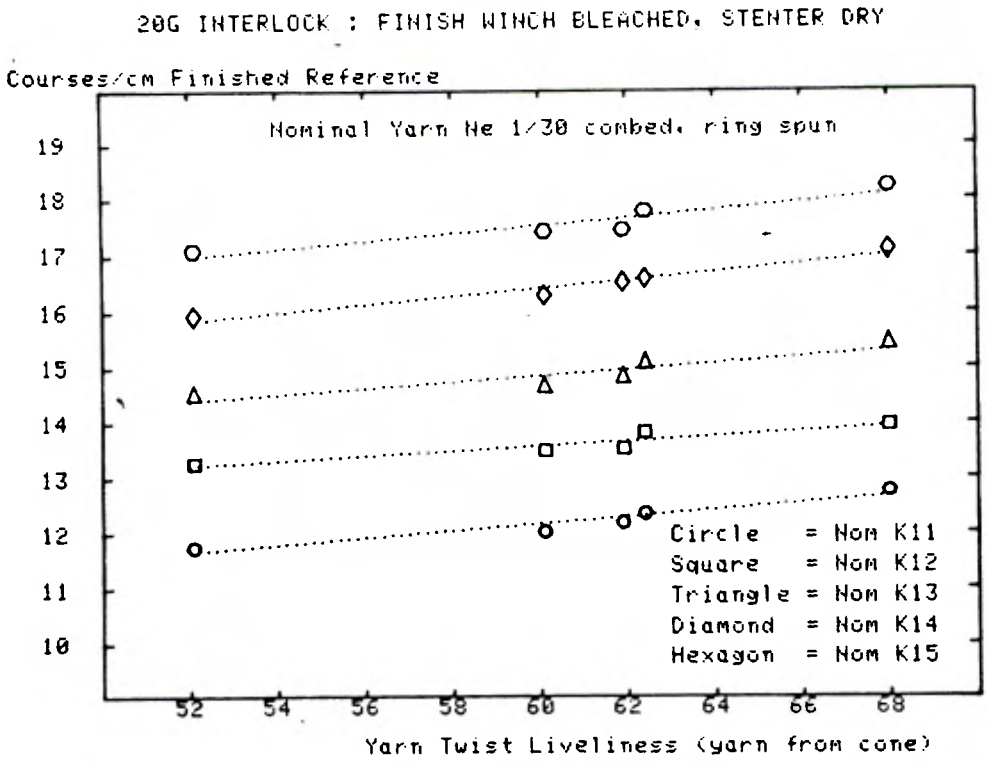


FIGURE 24

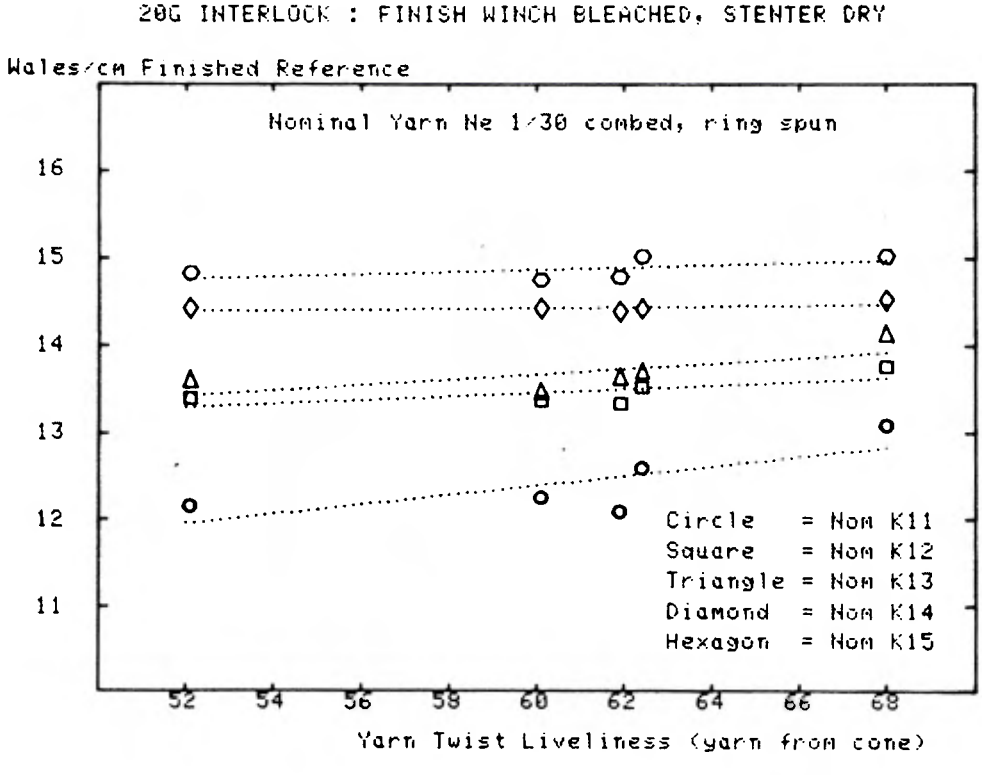


FIGURE 25

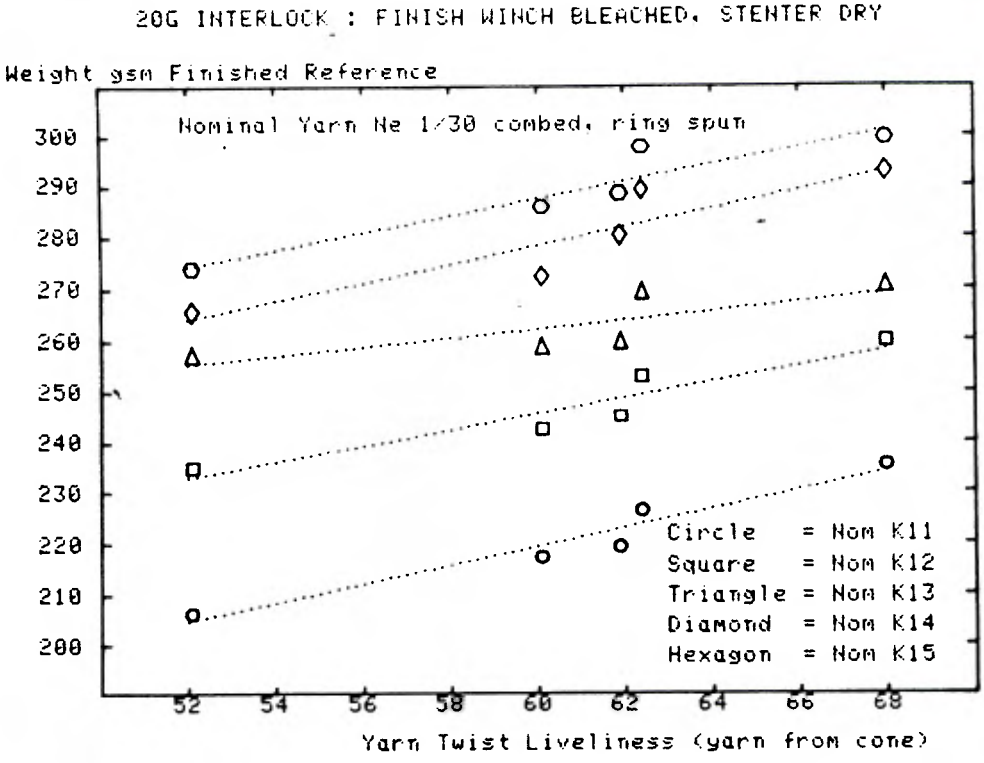


FIGURE 26

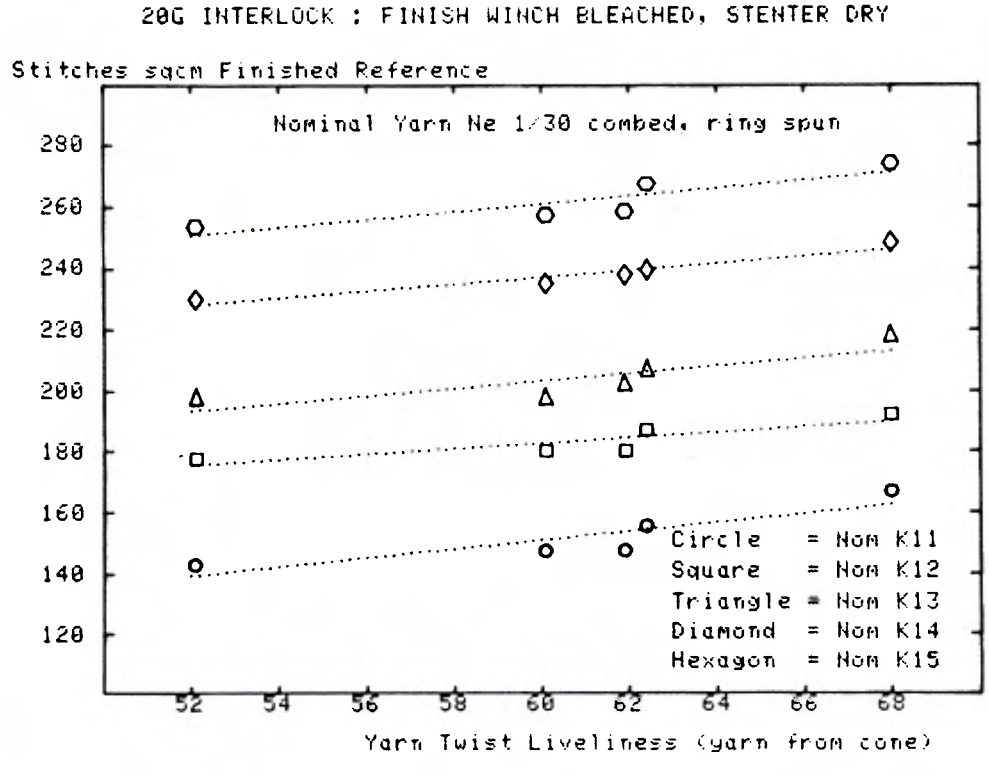


FIGURE 27

20G INTERLOCK :- EFFECT OF YARN TWIST

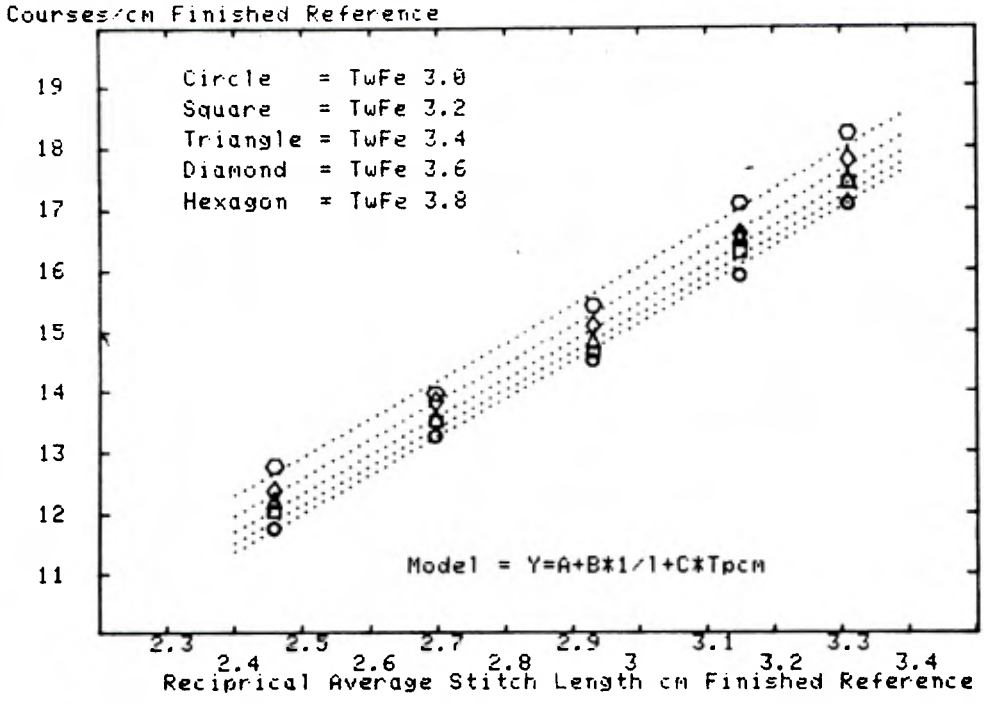


FIGURE 28

20G INTERLOCK :- EFFECT OF YARN TWIST

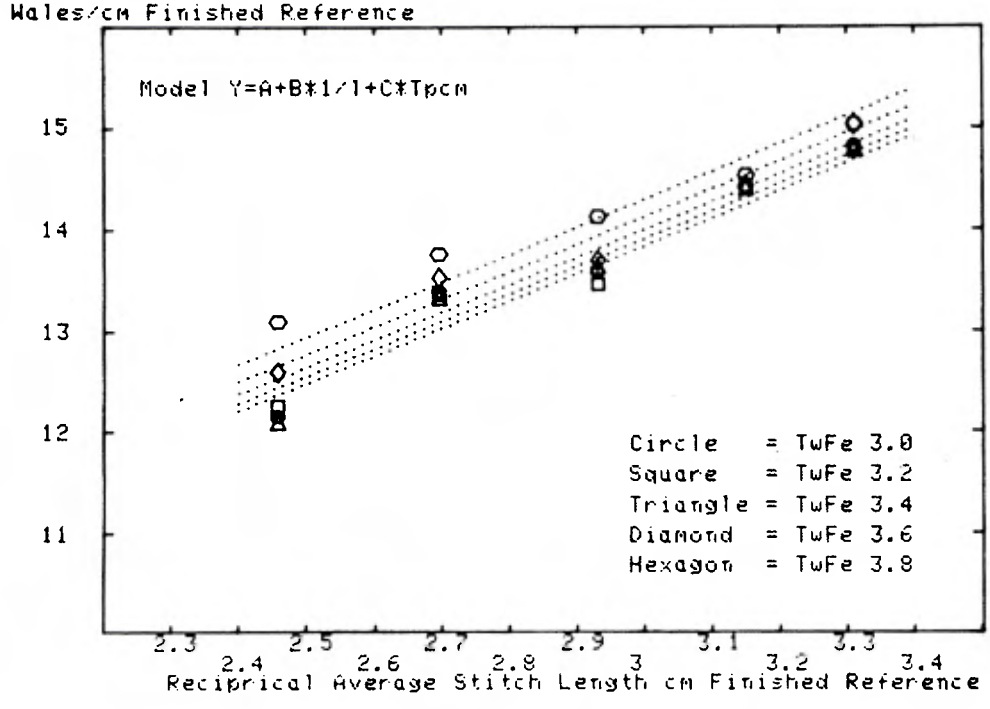


FIGURE 29

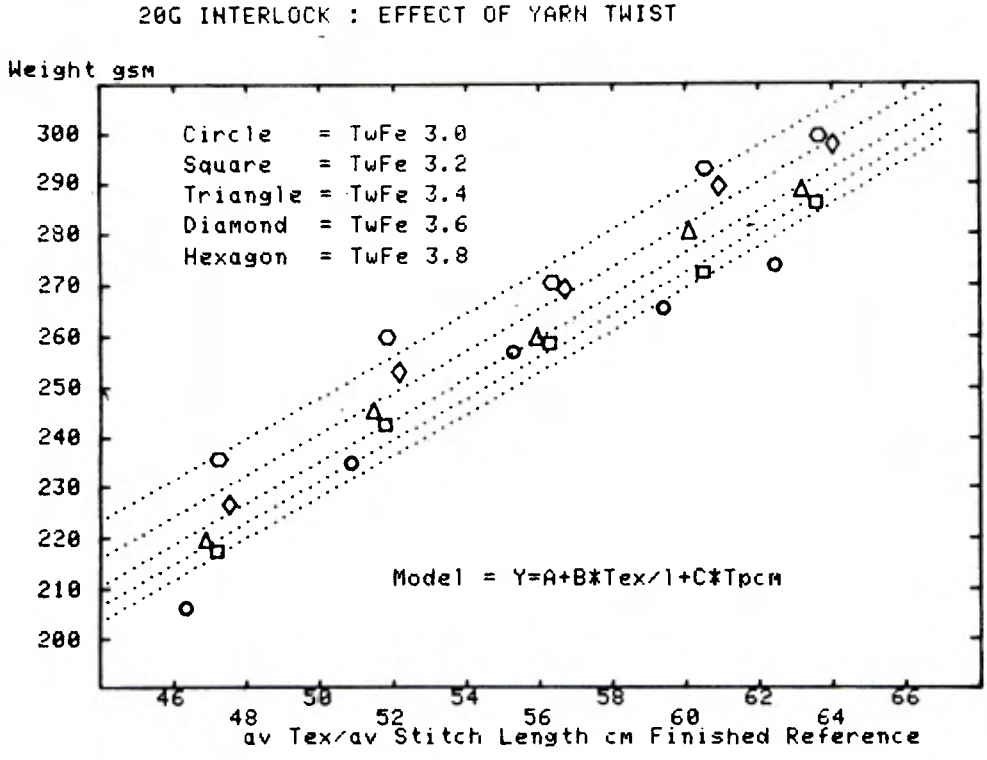


FIGURE 30

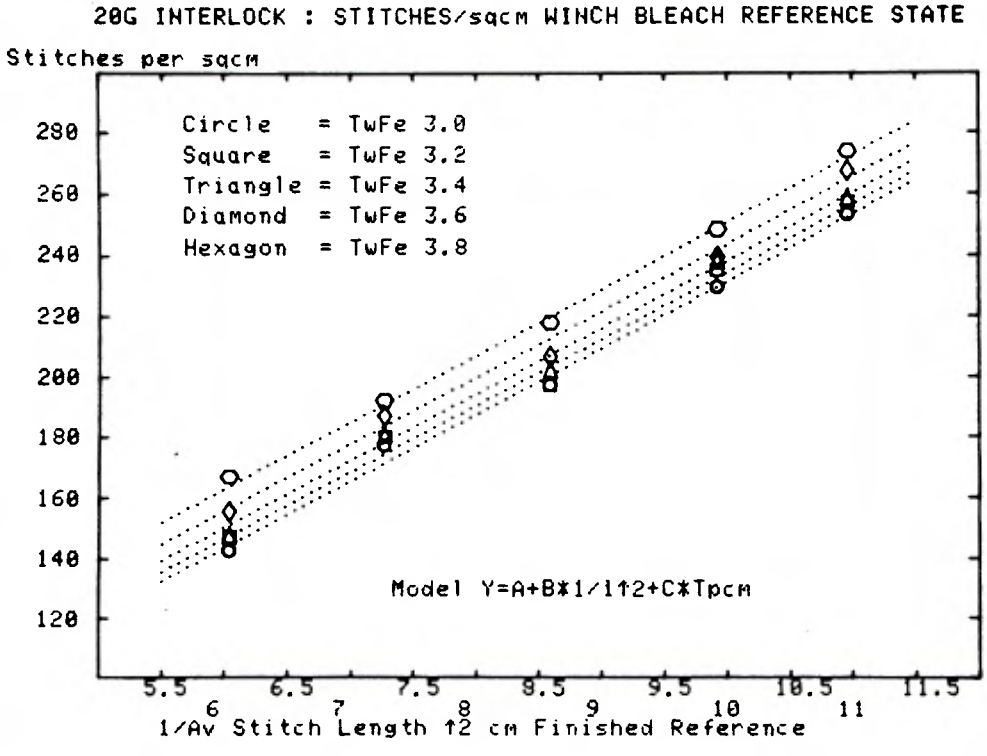
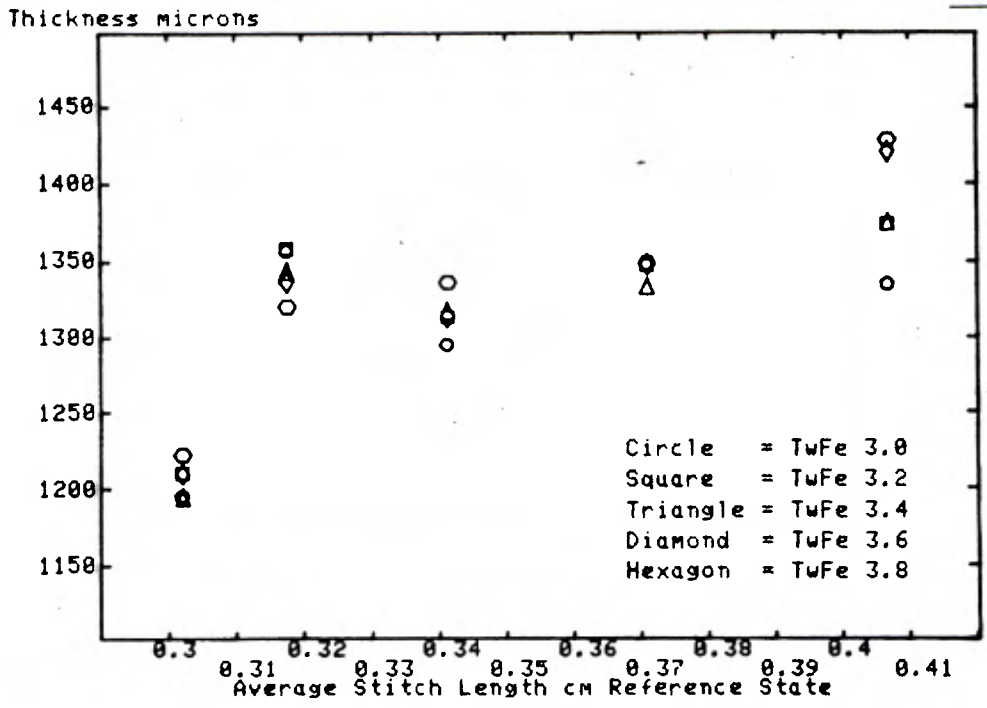


FIGURE 31

20G INTERLOCK : THICKNESS microns WINCH BLEACH REFERENCE STATE

FIGURE 32



20G INTERLOCK : THICKNESS microns WINCH BLEACH REFERENCE STATE

Nominal Yarn Count Ne 1/30

FIGURE 33