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Single Jersey Knitting Performance Part I: A Comparison of the Knitting Performance at Different Feeders and of Various Structures

by

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SINGLE JERSEY KNITTING PERFORMANCE

PART I : A COMPARISON OF THE KNITTING PERFORMANCE AT DIFFERENT FEEDERS AND OF VARIOUS STRUCTURES

by L. HUNTER, D. A. DOBSON and M. CAWOOD

ABSTRACT

The knitting performance, in terms of yarn breakages, at different feeders within a pattern repeat unit, has been compared for various single jersey structures produced on a 28 gauge machine. Feeders at which most breakages occurred have been identified for each structure thus enabling the knitter to improve knitting performance by supplying yarns with superior tensile properties at these feeders when feeder blending is being practised or is feasible. The performances of the different structures have also been compared at the same fabric mass per unit area.

KEY WORDS

Single jersey – knitting performance – Lacoste – Rough Tuck – Cross-tuck – Satin Stitch – Weft-knitted Locknit – yarn breakages.

INTRODUCTION

The relative knitting performance of the different feeders employed when knitting a Punto-di-Roma double jersey structure has been investigated by various workers[1–4]. From these studies it appeared that the performance of the different feeders relative to each other often depended, amongst other things, on the run-in-ratio and the particular type of machine. No such studies appear to have been carried out on single jersey structures. It is important to establish the relative performance of the different feeders employed in producing a repeat unit for any particular structure, because once the feeder (or feeders) at which most yarn breakages occur is pinpointed, means can be sought to improve its performance. For instance, if feeder blending is being used then the yarn with superior tensile properties can be knitted at the feeder where most strain is imposed on the yarn. Changing the stitch length (run-in) at this feeder, or, at other feeders which may be interacting with this feeder and which may be indirectly responsible for its relatively poor performance, could also lead to improved overall knitting performance.

It was decided to investigate the relative knitting performance (in terms of the number of yarn breakages) at the various feeders within a repeat unit for different single jersey structures. The performance of the different structures (of the same fabric mass per unit area) was also compared, and therefore structures where no feeder effect could occur were included in the investigation.

EXPERIMENTAL

Wool yarns (22 tex nominal), originally from the same undyed lot which had been sub-divided into four lots and dyed to four different shades prior to knitting, were used in the experiments. The friction of the yarns varied from roughly, 25 to 35 gf ($\mu > 0{,}2$) as measured on the SAWTRI yarn friction tester and could, to all intents and purposes, be regarded as unwaxed. These yarns were selected, since it was anticipated that the strains imposed on them during knitting would be higher than for waxed yarns, thus accentuating any differences between feeders and structures.

To determine in which particular course a yarn break occurred, different coloured yarns were used at the various feeders. Any differences between the yarns, caused by the different dye shades, were eliminated by knitting each of the four colours in turn at each of the feeders for any one set of conditions. For those structures with a six feeder repeat, the four colours were so arranged that feeders at which the two colours (which had to be duplicated) were being knitted could be distinguished, for instance, by having the one yarn knitting at an all-knit feeder while the other yarn (of the same colour) would be at the knit-tuck feeder. Any breakage occurring in this yarn could easily be attributed to the corresponding feeder since, in this particular case, a breakage at the all-knit feeder would cause a large hole while a breakage at a knit-tuck feeder would result in a smaller aperture in the fabric because the held loops from previous courses would still hold the courses (fabric) together at adjacent wales.

The yarns were knitted on a 60 feeder, 28 gauge, 26" diameter Wildt Mellor Bromley JSJ (2 256 needles) single jersey machine, (equipped with Rosen trip-tape positive feed), with a constant input tension of 3 gf and a constant take-down tension. A knitting speed of 14 r/min was employed.

Nine of the most common single jersey structures were selected (see Fig. 1), some of which (structures 1 and 2) were included merely for purposes of comparison since no feeder effect could exist. The description of the structures is that given in two previous publications[5, 6]. Twelve feeders on the machine (*viz.* 1 to 12) were utilised throughout and knitting was continued for 250 machine revolutions except for the plain structure (i.e No. 1) where the machine was run for 500 revolutions.

The yarn breakages occurring at the respective feeders within a pattern repeat were counted and the totals for the four different colours (i.e. per 1 000 machine revolutions for all but the plain, for which only 500 revolutions were knitted) are given in Table II. The yarn breakages per 10 metres of fabric are also given, purely for comparing the different structures, since the number of breakages per length of fabric is normally used in practice to assess the knitting performance of a fabric. The way of expressing the yarn breakage rate will not affect the assessment of the relative performance of the different feeders within a structure, except perhaps if the yarn breakages were expressed per unit length of yarn. The latter,

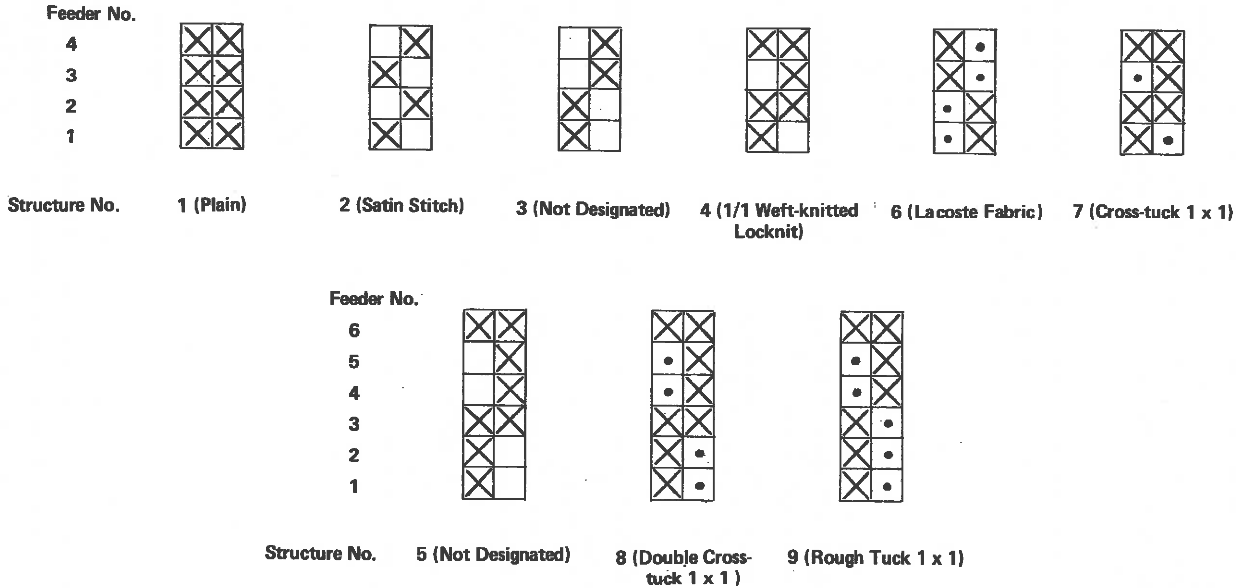

FIGURE 1

Diagrams of the various structures knitted
(⊠ = knit; □ = miss; ⊡ = tuck)

however, has no practical significance. The various structures were knitted to different degrees of tightness starting from a relatively loose structure with very few yarn breakages and increasing in tightness until a great number of yarn breakages occurred (see Table I). The idea was to determine whether the relative performance of the different feeders would be the same for a range of fabric tightness factors.

A choice of run-in-ratio had to be made when knit-tuck and all-knit or all-knit and knit-miss courses were incorporated into one structure. It was decided to use a 1:1 ratio for the former and a 1,5:1 ratio for the latter. The 1,5:1 run-in-ratio was arrived at as follows:

Let the course length (run-in) at an all-knit feeder be X metres and that at a knit-miss feeder (i.e. half the needles knitting and the other half missing) be Y metres. Y cannot be half of X if we are to have a similar loop length at those needles which are knitting since yarn will be required for the floats (i.e. for the needle spaces where the needles are not knitting). In this investigation where there are 2 256 needles (= N) and a needle spacing of 0,000907 m ($\frac{1}{28}''$) we have:

$$\begin{aligned} Y \text{ (in m)} &= 0{,}5\,X + 0{,}5\,N\,(0{,}000907) \\ &= 0{,}5\,X + 0{,}0004525\,N \\ &= 0{,}5\,X + 1{,}0208 \end{aligned}$$

Clearly, the required run-in-ratio will vary according to the course length (or run-in) being employed. Calculations showed it to vary from 1,45:1 to 1,49:1 for the range of course lengths (run-ins) considered here. For ease of application it was decided to fix the run-in-ratio at a rounded-off value of 1,5:1. Although this choice could have affected the relative performance of the different feeders in structures 4 and 5, it was considered unlikely that this run-in-ratio would deviate very much from those employed in industry.

A few subsidiary experiments were also carried out to determine whether spacing the 12 feeders equally around the circumference of the machine or changing the run-in, alternately, at certain feeders (increasing it by 10 *per cent*) had any effect on knitting performance. These results are given in Table III.

The unravelled course lengths (i.e. yarn consumed at any one particular feeder in one complete machine revolution) and dimensions of the fabrics knitted in the main experiments are given in Table I. The total mass of fabric knitted in each trial was calculated from the total number of courses knitted, the course length(s) and the yarn linear density (taken to be 22 tex throughout). The dimensions of the fabrics were determined in the dry-relaxed state approximately one week after the fabrics had been knitted.

The results obtained in the subsidiary experiments are given in Table III. The course lengths given are those obtained by run-in measurements on the machine and the fabric dimensions were determined approximately *two days* after knitting. These steps were taken to reduce the time involved and since only general trends

TABLE I

DETAILS OF THE VARIOUS FABRICS KNITTED

Structure No.	Course Length* (m)	Fabric Mass per unit area (g/m²)	Total Fabric Length Knitted (m)	Fabric Open Width (m)	Total Mass of Fabric Knitted (kg)
1	5,43	174	2,44	1,66	0,703
	5,61	170	2,65	1,64	0,741
	5,82	158	2,96	1,64	0,768
	5,97	152	3,12	1,66	0,788
	6,22	147	3,35	1,67	0,821
2	3,53	236	2,70	1,46	0,932
	3,71	223	2,97	1,48	0,979
	3,81	213	3,19	1,48	1,006
	3,94	189	3,74	1,47	1,040
3	3,58	233	2,76	1,47	0,945
	3,73	221	2,93	1,52	0,985
	3,81	207	3,20	1,52	1,006
	3,96	196	3,51	1,52	1,045
4	5,38/3,53	211	3,50	1,59	1,176
	5,54/3,71	196	3,90	1,60	1,221
	5,79/3,78	182	4,37	1,59	1,263
	5,99/3,99	177	4,69	1,59	1,317
5	5,51/3,66	216	3,31	1,58	1,129
	5,79/3,84	197	3,80	1,58	1,185
	5,92/3,96	189	3,98	1,62	1,218
6	5,36	209	3,38	2,00	1,415
	5,51	200	3,58	2,03	1,455
	5,79	192	3,81	2,09	1,529
	5,92	185	3,96	2,13	1,563
	6,05	178	4,19	2,14	1,597
7	5,54	191	3,89	1,97	1,463
	5,77	181	4,16	2,02	1,523
	5,94	177	4,33	2,05	1,568
	6,10	172	4,45	2,10	1,610
8	5,79	200	3,64	2,10	1,529
	5,87	198	3,64	2,15	1,550
	6,07	193	3,82	2,17	1,602
	6,17	190	3,82	2,25	1,629
9	5,89	205	3,49	2,17	1,555
	6,07	204	3,53	2,22	1,602
	6,20	197	3,73	2,23	1,637
	6,35	193	3,80	2,28	1,676
	6,45	188	3,86	2,35	1,703

*Where two values are given the first is that of the all-knit course (feeder) and the second is that of the knit-miss course (feeder).

were of interest here. The absolute values are, therefore, not entirely comparable with those given in Tables I and II, although all trends are considered reliable.

RESULTS AND DISCUSSION

Knitting Performance at Individual Feeders:

Satin Stitch (No. 2)

This structure is completely symmetrical and no effect attributable to different feeders should be present. Nevertheless, from Table II it is apparent that the *odd feeders* (i.e. feeders 1, 3, 5, 7, 9 and 11) represented by feeder 1, since the others are merely pattern repeats to make up 12 feeders, consistently produced more breakages than the even feeders (feeders 2, 4, 6, 8, 10 and 12) represented by feeder 2. This suggests that the grouping of the 12 feeders could have prejudiced the results obtained on the first feeder (i.e. feeder 1) in the group of 12, possibly due to the action of the take-down tension on the held loops when the needles moved from feeder 12 past 48 non-knitting feeders to feeder 1. This aspect will be returned to later in this report.

Structure No. 3 (not designated)

In this structure, the odd feeders were equivalent and so were the even feeders. Unless the first (or possibly last) feeder, therefore, was prejudiced by the feeder arrangement it is to be expected that the odd feeders (represented by feeders 1 and 3) should behave similarly and the even feeders (represented by feeders 2 and 4) should behave similarly. From Table II it is clear that, grouped in this way, the even feeders consistently caused the greater number of yarn breakages, indicating that the strain imposed on the yarn at these feeders, was greater than that imposed on the yarn at the other feeders. When feeder blending therefore, it would be advisable to feed the yarn with the superior tensile properties at the even numbered feeders when the structure is knitted in the sequence indicated in Fig. 1 (see Appendix). The explanation for the behaviour of the feeders can be found in the fact that at the even feeders the needles are required to hold their loops for two consecutive knitting cycles without casting off (knocking over). The tension in these loops, due to the take-down tension would therefore be much higher when they are knocked-over, than that existing when the loops formed at the odd feeders are cast off. According to this reasoning, the yarn breakages therefore should occur at knock-over and not when the loop is being formed. The consistent differences within both the odd and even feeders, possibly could be ascribed to the way in which the feeders were grouped and no importance is attached to this trend. This will be referred to again later.

TABLE II

NUMBER OF YARN BREAKAGES AT INDIVIDUAL FEEDERS (AND THEIR REPEATS WITHIN THE 12 FEEDERS)

				Yarn breakages at individual feeders											
				Feeder 1		Feeder 2		Feeder 3		Feeder 4		Feeder 5		Feeder 6	
Structure	Run-in or course length (m)	Total no. of Yarn breakages	Total no. of yarn breakages per 10 m of fabric	Total	Breakages per 10 m of fabric	Total	Breakages per 10 m of fabric	Total	Breakages per 10 m of fabric	Total	Breakages per 10 m of fabric	Total	Breakages per 10 m of fabric	Total	Breakages per 10 m of fabric
1) Plain	5,43	138	566												
	5,61	49	185												
	5,82	22	74												
	5,97	18	58												
	6,22	8	24												
2) Satin Stitch	3,53	2 921	10 820	1 741	6 448	1 180	4 370								
	3,71	287	966	155	522	132	444								
	3,81	31	97	19	60	12	38								
	3,94	3	8	2	5	1	3								
3) Not designated	3,58	3 937	14 264	167	605	2 457	8 902	233	844	1 080	3 913				
	3,73	218	744	8	27	132	451	15	51	63	215				
	3,81	22	69	2	6	15	47	1	3	4	13				
	3,96	2	6	0	0	2	6	0	0	0	0				
4) 1/1 Weft-knitted Locknit	5,38/3,53	718	2 051	413	1 180	62	177	111	317	132	377				
	5,54/3,71	114	292	62	159	11	28	19	49	22	56				
	5,79/3,78	21	48	13	30	0	0	7	16	1	2				
	5,99/3,99	13	28	3	6	6	13	2	4	2	4				
5) Not designated	5,51/3,66	963	2 909	10	30	397	1 199	80	242	9	27	257	776	210	634
	5,79/3,84	154	405	3	8	75	197	19	50	3	8	34	89	20	53
	5,92/3,96	16	40	2	5	1	3	3	8	0	0	1	3	9	23
6) Lacoste Fabric	5,36	1 669	4 938	717	2 121	0	0	940	2 781	12	36				
	5,51	161	450	75	209	2	6	80	223	4	11				
	5,79	18	47	11	29	0	0	7	18	0	0				
	5,92	10	25	6	15	0	0	2	5	2	5				
	6,05	9	21	3	7	1	2	2	5	3	7				
7) Cross-Tuck 1 x 1	5,54	687	1 766	0	0	213	548	0	0	474	1 219				
	5,77	117	281	0	0	27	65	1	2	89	214				
	5,94	41	95	0	0	7	16	0	0	34	79				
	6,10	22	49	0	0	6	13	0	0	16	36				
8) Double Cross-tuck 1 x 1	5,79	960	2 637	0	0	0	0	243	668	2	5	0	0	717	1 970
	5,87	292	802	0	0	0	0	87	239	6	16	1	3	198	544
	6,07	78	204	0	0	0	0	25	65	0	0	0	0	53	139
	6,17	95	249	0	0	0	0	26	68	0	0	0	0	69	181
9) Rough-tuck 1 x 1	5,89	787	2 255	2	6	1	3	1	3	598	1 713	1	3	184	527
	6,07	210	595	0	0	0	0	0	0	129	365	0	0	81	229
	6,20	228	611	4	11	0	0	0	0	137	367	0	0	87	233
	6,35	74	195	4	11	0	0	0	0	38	100	0	0	32	84
	6,45	34	88	1	3	0	0	0	0	18	47	1	3	14	36

1/1 Weft-knitted Locknit (No. 4)

From Fig. 1 it is clear that, barring any effect of feeder grouping and possibly of actual physical differences between the feeder guides, etc., the even feeders should have similar performances. Nevertheless, from Table II it is apparent that this is not so. Feeder 1 (which includes feeders 1, 5 and 9) shows the most yarn breakages, followed by feeder 4 (which includes feeders 4, 8 and 12). This suggests that the performance of the first feeder in the sequence of 12, and, to a lesser extent, the last feeder, could have been prejudiced by the grouping of the feeders. No clear pattern therefore is evident for this structure if the feeders are grouped in a logical manner.

Structure No. 5

This structure has a six feeder repeat. From the pattern it could be expected that feeders 1 and 4 will behave in a similar manner, as will feeders 2 and 5, and feeders 3 and 6. The results given in Table II show that, grouped in this way, feeders 2 and 5 consistently performed the worst, followed by feeders 3 and 6 with feeders 1 and 4 performing best. In practice, therefore, feeding a yarn with superior tensile properties at feeders 2 and 5 should effect a significant reduction in the number of yarn breakages. Differences between feeders within the above grouping could be due only to the arrangement of the feeders on the machine. It is difficult to find an explanation for the pattern observed above.

Lacoste Fabric (No. 6)

In this structure, which has a four feeder repeat, one would expect both the odd and even feeders to produce similar breakage patterns. The odd feeders, represented by feeders 1 and 3 (but incorporating feeders 1, 3, 5, 7, 9 and 11), consistently produced many more breakages than the even feeders. Here was little evidence of differences within even or odd feeders. It is clear, therefore, that supplying a yarn with superior tensile properties at the odd feeders (if the numbering corresponds to the present sequence) should effect an improvement in knitting performance. From the breakage pattern exhibited by this structure it would appear that the yarn breakages occurred when the loop was being formed, and not when it was being knocked-over. This was perhaps due to excessive yarn to yarn frictional forces between the loop being formed and the held stitch being cast off, the latter having been held on the needles for two consecutive feeders before being cast off (knocked-over) at the third.

Cross Tuck 1 x 1 (No. 7)

Fig. 1 shows that the odd feeders (courses) are similar for this structure as are the even feeders. Table II shows that their behaviour was similar, many more breakages occurring at the even than at the odd feeders. More strain, therefore, was imposed on the yarn supplied at the all-knit feeders than that imposed on the yarn supplied at the knit-tuck feeders, probably due to alternate loops in the all-knit courses having been held, while the tuck stitches were formed at the odd feeders. This would result in higher tension in these loops, and therefore in a greater number of yarn breakages at knock-over. Supplying a yarn with superior tensile properties at the all-knit feeder, when practising feeder-blending, should therefore prove advantageous. The higher breakages of feeder 4 relative to feeder 2 could be the result of the feeder arrangement (grouping) used in this study.

Double Cross-tuck 1 x 1 (No. 8)

This structure has a six feeder repeat with feeders 1 and 4, feeders 2 and 5, and feeders 3 and 6 similar. Grouped in this way it is clear from Table III that the all-knit feeders (3 and 6) produced by far the most yarn breakages. The reasons for this are probably the same as those advanced for the previous structure, except that here the loops are held for two feeding cycles. The second highest number of breakages appears to have occurred at feeder 4 and the explanation for this is probably the same as that advanced for the Lacoste fabric (No. 6). The consistent difference between feeders 3 and 6 could be due to the feeder arrangement used here, and little importance should be attached to this trend.

Rough Tuck 1 x 1 (No. 9)

Here virtually every feeder has to be assessed individually and it would be difficult therefore to pick up any differences due to the particular feeder arrangement used here. It is apparent, however, that feeder 4 consistently produced the most breakages followed by feeder 6. This could be due to the fact that when the loops were formed at feeder 4, they had to be drawn through the stitches which had been on the needles (i.e. held) since feeder 6. The tension on these stitches and, therefore, inter-yarn frictional forces during loop formation, would be high and could cause breakages in the loops being formed. This reasoning logically also leads to an explanation for the high breakage rate at feeder 6 since these loops were cast-off (knocked-over) under a high tension. Here (i.e. feeder 6) the breakages, therefore, should occur during knock-over and not during loop formation. Stronger and more extensible yarns at these feeders, therefore, should lead to improved knitting performance.

General comments:

Table I gives some information as to how the fabric dimensions (in the dry-relaxed state), width in particular, varied according to structure and fabric tightness (i.e. course length or run-in). The greater width of the tuck structures is immediately apparent. Fabric tightness (i.e. course length) generally had only a slight effect on fabric width although the effect should increase as the fabric continues to relax until it reaches its minimum energy state.

TABLE III

RESULTS OBTAINED IN SUBSIDIARY EXPERIMENTS WHERE EFFECTS OF FEEDER ARRANGEMENT* AND INCREASING COURSE LENGTH AT SELECTED FEEDERS WERE INVESTIGATED

Structure No.	Course Length+ (m)	Fabric Mass per Unit Area (g/m²)	Fabric Width (m)	Yarn breakages per 10 metres of fabric at individual feeders					
				Feeder 1	Feeder 2	Feeder 3	Feeder 4	Feeder 5	Feeder 6
3	3,68 (all feeders)	209	1,49	128	1 651	154	2 214	—	—
	4,06 (1 & 3)/3,68 (2 & 4)	198	1,54	0	36	0	60	—	—
	3,68 (1 & 3)/4,06 (2 & 4)	188	1,49	11	0	0	33	—	—
4	5,45 (2 & 4)/3,68 (1 & 3)	183	1,61	127	196	176	118	—	—
	5,54 (2 & 4)/4,06 (1 & 3)	185	1,65	38	86	96	77	—	—
	6,1 (2 & 4)/3,68 (1 & 3)	167	1,59	33	8	66	8	—	—
5	5,54 (3 & 6)/3,68 (1,2,4 & 5)	201	1,60	23	497	147	11	1 390	316
	6,1 (3 & 6)/3,68 (1,2,4 & 5)	182	1,59	0	265	10	10	392	39
	5,54 (3 & 6)/4,06 (1,2,4, & 5)	189	1,66	0	21	10	0	0	42
6	5,79 (all feeders)	184	2,09	90	0	40	0	—	—
	6,38 (1 & 3)/5,79 (2 & 4)	180	2,24	30	0	30	0	—	—
	5,79 (1 & 3)/6,38 (2 & 4)	190	2,19	62	0	31	0	—	—
7	5,79 (all feeders)	170	2,02	0	90	0	162	—	—
	6,38 (2 & 4)/5,79 (1 & 3)	163	2,07	0	8	0	17	—	—
	5,79 (2 & 4)/6,38 (1 & 3)	168	2,15	0	63	0	171	—	—
8	5,79 (all feeders)	193	2,10	0	0	1 569	0	0	2 131
	6,38 (1,2,4 & 5)/5,79 (3 & 6)	182	2,21	10	0	554	0	0	1 188
	5,79 (1,2,4 & 5)/6,38 (3 & 6)	187	2,13	0	0	71	0	0	343
9	5,79 (all feeders)	208	2,18	36	0	0	1 404	0	738
	5,79 (1 to 5)/6,38 (6)	203	2,19	0	0	0	1 219	0	23
	6,38 (1 to 5)/5,79 (6)	202	2,26	0	0	0	440	0	165

*Feeders spaced equally around circumference of machine in all these trials
+Nominal values — feeder numbers to which they apply given in parenthesis

Subsidiary Experiments:

To establish whether or not the feeder arrangement used in the main experiment (*viz.* all twelve feeders clustered together) had biased any of the results, additional experiments were carried out with the 12 feeders spaced evenly around the circumference of the machine. In view of the consistent results obtained in the main experiment it was considered necessary to carry out only one experiment (i.e. one course length or run-in) for each of structures 3 to 9. Structures 1 and 2 were excluded since they should not exhibit any feeder effect and had been included originally merely for purposes of comparison. The results obtained in these additional experiments are given in Table III (the first row of each set of results). From these results it is apparent that for all but structure 4 (1/1 Weft-knitted Locknit) the trends observed originally, when the feeders were grouped together, were the same as those observed with the new feeder grouping. The conclusions drawn for the original feeder arrangement therefore are considered generally to be valid for the structures mentioned. Table III shows that differences within a feeder grouping were generally reduced or eliminated by the new feeder arrangement, which confirms the opinion expressed throughout this report that, logically, such differences could only be due to the feeder arrangement. No importance was therefore, attached to such differences.

With structure 4 the pattern of yarn breakages is confused and the only conclusion which can reasonably be drawn is that, under the conditions existing in this investigation, no logical or consistent pattern of feeder breakage could be observed for this particular structure.

Although it has been suggested throughout this report that yarns with superior tensile properties could be used profitably at those feeders where most yarn breakages occurred (and this was confirmed for structure 3 – see Appendix), it was considered to be of some interest to carry out a limited trial to see whether slackening (i.e. increasing the run-in or course length) at any one of the groups of feeders would effect an improvement in knitting performance. Once again, because of the consistent results obtained earlier when knitting with different course lengths (i.e. tightnesses) these trials were limited to basically only one course length per structure and the run-in was slackened at each feeder group, in turn, by 10 *per cent* from this. The yarn breakages obtained are given in Table III.

Table III shows that increasing the course length at any group of feeders effected an overall reduction in the number of yarn breakages with the greatest reduction generally taking place at those feeders at which the change took place, particularly when these displayed the most breakages originally. Only in a few cases (structures 3 and 5) were the changes sufficiently large to cause a reverse in the feeder effect observed previously. Nevertheless, changes in course length also caused changes in the fabric width and mass per unit area and this could be unacceptable in practice. The different effects, on fabric width and mass per unit area, obtained by slackening the different types of courses (e.g. whether it be all-knit, knit-miss or knit-tuck) are also evident from the results given in Table III.

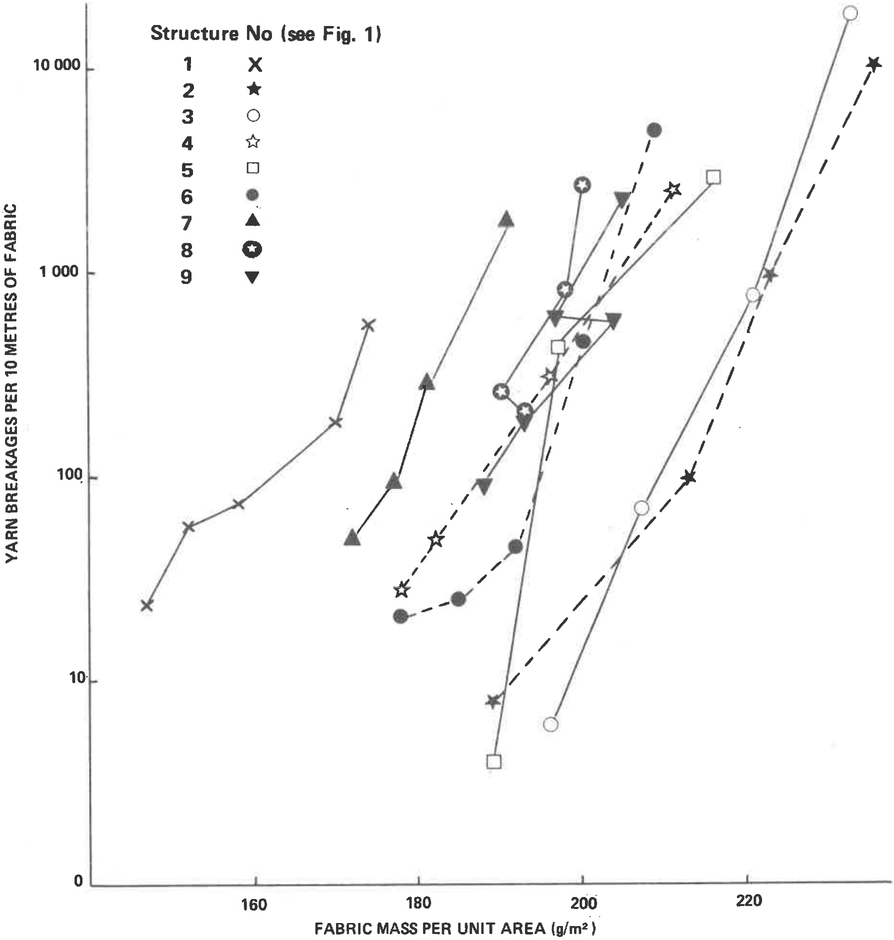

FIGURE 2

Yarn breakages per 10 metres of fabric vs fabric mass per unit area

Comparison of the overall knitting performance of the various structures:

In Fig. 2 the total number of yarn breakages (holes) per 10 metres of fabric has been plotted against fabric mass per unit area (in the dry-relaxed state) for the various structures. It is clear that, under the conditions employed in this investigation, considerable differences existed between the knitting performance of some of the structures at the same mass per unit area. The plain structure generally had the worst knitting performance. This is not too difficult to explain since this structure represents the optimum fabric mass – cover relationship, any increase in mass must be obtained by decreasing stitch length with a consequent increase in yarn breakages. Structures 2 (Satin Stitch) and 3 gave the best knitting performance, particularly where relatively heavy fabrics were being knitted.

SUMMARY AND CONCLUSIONS

The knitting performance at different feeders within a pattern repeat, has been compared for a range of single jersey structures (seven in all including Satin Stitch, 1/1 Weft-knitted Locknit, Lacoste fabric, Cross-tuck 1 x 1). Wool yarns (22 tex) were knitted to various tightnesses (course lengths) on a 28 gauge single jersey Jacquard machine, equipped with positive feed, and the yarn breakage pattern at the different feeders ascertained in each case. A run-in-ratio of 1,5:1 was employed when all-knit and alternate knit-miss courses were incorporated in the same structure while a run-in-ratio of 1:1 was used when knit-tuck and all-knit courses were incorporated in the same structure. Consistent results were obtained for the different course lengths.

For structure No. 3 (knit odd needles miss even needles and repeat, miss odd needles knit even needles and repeat) most breakages occurred at the *second* and *fourth* feeders. No clear pattern of yarn breakages emerged for the 1/1 Weft-knitted Locknit structure (No. 4). For structure No. 5 (knit odd needles miss even needles and repeat, knit all needles, miss odd needles knit even needles and repeat and finally knit all needles – i.e. 6 feeder repeat) most yarn breakages occurred at feeders 2 and 5, followed by feeders 3 and 6 (the latter two being the all-knit feeders).

In the case of the Lacoste fabric (structure No. 6 – tuck odd needles knit even needles and repeat, knit odd needles tuck even needles and repeat) most yarn breakages by far occurred at feeders 1 and 3. For the Cross-tuck 1 x 1 structure (knit odd needles tuck even needles, all-knit, tuck odd needles knit even needles, all-knit) most yarn breakages occurred at the all-knit feeders, which was also the case for the Double Cross-tuck 1 x 1 structure (knit odd needles tuck even needles and repeat, all-knit, tuck odd needles knit even needles and repeat, and all-knit). For the Rough-tuck 1 x 1 structure (knit odd needles tuck even needles and repeat twice, tuck odd needles knit even needles and repeat, and all-knit) most yarn breakages occurred at feeders 4 and 6.

Knowing the above patterns of yarn breakages, therefore, the knitter should be able to improve his knitting efficiency by supplying yarn with superior tensile properties at those groups of feeders where most yarn breakages occur when feeder blending is at all feasible. This was confirmed for structure 3 (results given in the Appendix). Slackening the stitches (i.e. increasing course length) at these feeders in particular, should also effect a general reduction in the yarn breakage rate although this could perhaps lead to unacceptable changes in fabric dimensions, mass per unit area and appearance.

In the light of some additional experiments carried out it can be concluded that a careful selection of the run-in-ratio could lead to improved knitting performance and also possibly to different patterns of yarn breakages in some cases.

The total number of yarn breakages per 10 metres of fabric was also compared for the different structures at a range of fabric mass per unit area values from which it was concluded that, under the particular conditions employed in this study, the plain jersey structure gave the poorest knitting performance. That of structures 2 (Satin Stitch) and 3 was apparently best, particularly for fabric mass per unit area values exceeding 190 g/m^2.

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APPENDIX

EFFECT OF FEEDER BLENDING ON YARN BREAKAGE RATE

Throughout this report is has been suggested that, where certain feeders show a much higher yarn breakage rate than others, this could be reduced (i.e. the knitting performance could be improved) by feeding a yarn with superior tensile properties at these particular feeders. To confirm this a 60% cotton/40% polyester yarn (R20 tex/2) was feeder blended with the 22 tex wool yarns used in the main investigation. For this purpose, *structure 3* (see Fig. 1) was selected and knitted to a course length of 3,56 metres (at each of the 12 feeders). Appendix Table I gives details of the numbers of yarn breakages (per 250 machine revolutions) for the two different yarns being knitted at the two groups of feeders.

APPENDIX TABLE I

EFFECT OF FEEDER BLENDING ON THE NUMBER OF YARN BREAKAGES PER 250 MACHINE REVOLUTIONS (12 FEEDERS IN OPERATION AND A COURSE LENGTH OF 3,56 METRES)

Yarn supplied at the respective feeders	Yarn breakages per 250 machine revolutions				
	Feeder 1*	Feeder 2*	Feeder 3*	Feeder 4*	Total
All-wool	107	995	53	716	1 871
Cotton/Polyester at odd feeders and wool at even feeders	0	646	0	536	1 182
Wool at odd feeders and cotton/polyester at even feeders	131	0	105	0	236

*And their repeats within the 12 feeders

It is clear from the above table that, when the cotton/polyester yarn was knitted at those feeders (even feeders) at which most yarn breakages originally occurred, the number of yarn breakages at these feeders decreased to zero and the total number of breakages dropped from 1 871 to 236. Knitting the cotton/polyester yarn at the odd feeders also reduced the number of breakages significantly although not to the same extent as the former. This then confirms the recommendations made in the text concerning the effect of the correct choice of feeder blending on the yarn breakage rate for this particular structure (i.e. structure 3). It is considered reasonable to assume that the other structures will show the same trends.

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