

# Performance of Rib Structures from Bouclé Yarns

## Abstract

*In this experimental study, the effects of the production parameters of bouclé yarn, such as overfeed ratio, the binding yarn's twist direction and twist amount on the properties of 2×1 and 2×2 rib structures have been investigated. It was observed that changes in the studied parameters affected the stitch density, thickness and abrasion behaviour of both types of fabric.*

**Key words:** overfeed ratio, binder yarn, bouclé yarn, rib fabric.

## Introduction

Bouclé yarn is a compound yarn comprising a twisted core combined with an effect yarn (or roving) so as to provide wavy projections on its surface [2, 7]. The effect is achieved by the differential delivery of the effect component as compared with the core yarns. For the production of bouclé yarns, three different spinning systems are available: the ring spinning system, the hollow spindle spinning system and the combined spinning system. In the combined spinning system, in which the hollow spindle and ring spindle are combined in a single machine, the wrapped yarn is given some true twist by the ring spindle located immediately beneath the hollow spindle. There are two kinds of twists in the yarn. One is the 'undertwist', that is, when the core and the effect threads wrap around each other. The other is the 'overtwist', that is, when the fixing thread wraps around the core and effect threads.

The fundamental parameters involved in the production of bouclé yarns and their effect on the dimensions and the number of loops in the bouclé yarns, as well as on the properties of fabrics knitted, have been studied by various researchers [1, 5, 8]. Petruyte [6] developed mathematical

models that were informative about the yarn structure produced by hollow spindles. Mole & Knox [3] also studied how bouclé profiles appear in woven and knitted fabrics. Knitted fabric trials have shown that a rib structure for a bouclé yarn was too rigid and the yarn profile was hidden. With a single jersey structure, the yarn effect was on the technical back of the fabric and appeared looped. Recently, Nergis & Candan [4] studied the effects of overfeed ratio, twist direction and twist amount of the binder yarn, and of the effect material count on the properties of bouclé yarns and their performance in single jersey and rib knit structures. They found that both the technical face and back of single-jersey fabrics were less resistant to abrasion than the rib structures. They also observed that the bouclé effect is more uniformly distributed on both the technical face and back of the rib fabrics. For these reasons, and also taking the scarcity of studies on structures from novelty yarns into consideration, we adopted the combined spinning system in order to investigate the effects of overfeed ratio, twist direction and twist amount of the binder yarn and effect material count on the performance of bouclé yarns in 2×1 and 2×2 rib knit structures.

## Method and material

The core, the binder and the effect of the yarns reported in this study were made of 31 tex nylon, 7,7 tex nylon and 66 tex high bulk acrylic respectively. In a group of bouclé yarns, 66 tex × 2 effect yarns were used. The twist amounts of the binder yarn around the core and the effect yarns were 450, 500 and 550 t/m for both S and Z twist directions, and 100% and 200% were used as overfeed ratios.

The coding of the yarns was obtained on the basis of the following arrangement: count of effect material/twist direction/

twist amount/overfeed. For example, 66 tex/S/450/100 means that this bouclé yarn's effect material is made from 66 tex high bulk acrylic, the twist direction of the binder yarn is S, the twist amount is 450 t/m and the overfeed is 100%.

The bouclé yarns were produced on a Mispa FN 64 model combined fancy spinning system. 2×1 and 2×2 rib fabrics from these yarns were knitted on a Shima Seiki SES 122 S model flat-knitting machine. All fabrics were knitted on the same knitting machine parameters.

We appraised the bouclé yarn by determining the height and the number of the effects (bouclé profiles) formed by the effect component. Since there is not a standard method of doing so, we carried out the measurements in the way explained below:

For each yarn, we counted the number of the effects in 2.5 metres of yarns and defined the number of effects in 10 cm. of the bouclé yarn. To determine the height of the effects, we took every 10 cm. of 2.5-metre yarn and drew two lines bordering the highest effects. Then we measured the distance between the borders, and calculated a mean for the maximum effect height.

The fabrics were subjected to areal density, fabric thickness, and abrasion resistance tests according to standards ISO 3801, BS 2544, and BS 5690 respectively. To determine the abrasion resistance of the fabrics, the weight loss (%) of the samples was calculated at the end of 10,000 rubs. The abrasion test was applied on the technical face of the fabrics, and abrasion tests were performed 4 times for each fabric sample. The t test was used to compare the differences between the average of the tested results.

## ■ Results and discussion

The results of the measurements regarding the properties of bouclé yarns and 2×1 & 2×2 rib fabrics are given in Tables 1, 2, 3 and 4 (see also page 52), and from these we draw the following conclusions:

From Table 1, it can be observed that the yarn count changes when the overfeed ratio and effect yarn count change. Employing higher overfeed ratio and coarser effect material results in the production of coarser yarns, since the amount of the effect material included in the unit length of the bouclé yarn increases. Besides, it is evident that the number of the effects in the S-twisted yarns at 100% overfeed is higher than that of the yarns at 200%, while Z-twisted bouclé yarns have the opposite tendency. It also appears that the number of the effects in S-twisted yarns is higher than that of the Z-twisted yarns, irrespective of the overfeed ratios. Effect height tends to increase when the overfeed is increased from 100% to 200%, and the difference is statistically significant at a 95% level of confidence. Although the differences are not statistically significant, the maximum height of Z-twisted bouclé yarns seems to be slightly higher than that of the S-twisted yarns. The differences between S and Z twisted bouclé yarns in terms of effect number and height might be due to the fact that the twist direction of the effect yarn itself, which is an S-twist, is the same as that of the binder yarn.

For both 2×1 and 2×2 fabrics, the stitch density of fabrics knitted with yarns of 200% overfeed has been lower than that of fabrics knitted with yarns of 100% overfeed (Tables 2, 3 and Figure 1 - see page 52). The differences between the stitch density values of the fabrics were found to be statistically significant, at 95% level of confidence. A similar result was also observed for the fabrics from S-twisted yarns. Changing the overfeed ratio affects the bouclé profiles in the yarn, and the height of the effects increases when the overfeed ratio is increased. Moreover, the number of the S-twisted yarns is greater than that of the Z-twisted ones. In the light of these results, it might be concluded that longer height, together with the greater number of bouclé profiles in the yarn prevent the loops from getting closer during the dry relaxation process, which in turn causes lower stitch density. The wale density values may especially indicate that de-

**Table 1.** Bouclé yarn properties.

Yarn Code		Boucle yarn count- actual,		Number of effects per 10 cm	Max. effect height, mm
denotation	No.	tex	Nm		
66tex/S/550/100	1	201	4.97	63.5	3.6
66tex/S/500/100	2	199	5.02	65.0	4.2
66tex S/450/100	3	194	5.16	68.9	4.0
66tex/Z/550/100	4	210	4.76	43.4	4.4
66tex/Z/500/100	5	195	5.12	45.2	4.4
66tex/Z/450/100	6	190	5.26	40.0	4.0
66tex×2/S/500/100	7	400	2.50	98.4	4.7
66tex×2/Z/500/100	8	340	2.94	90.0	5.2
66tex/S/550/200	9	267	3.74	49.4	6.2
66tex/S/500/200	10	284	3.52	52.4	5.5
66tex/S/450/200	11	269	3.72	59.0	5.7
66tex/Z/550/200	12	286	3.50	51.9	6.2
66tex/Z/500/200	13	270	3.70	50.4	5.8
66tex/Z/450/200	14	267	3.74	47.4	6.0

**Table 2.** Properties of 2×1 rib fabrics from bouclé yarns according to Table 1.

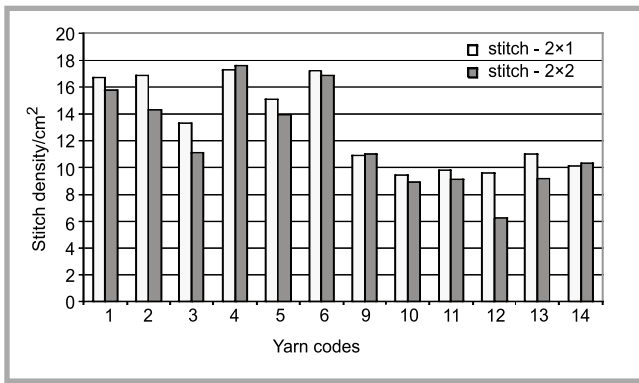
Yarn Code	Yarn count, tex (Nm)	Wales per cm	Courses per cm	Stitch density per cm <sup>2</sup>	Area weight, g/m <sup>2</sup>	Thickness, mm
1	200 (5)	4.4	3.8	16.7	398	3.9
2	200 (5)	4.4	3.8	16.9	396	3.1
3	200 (5)	3.4	3.9	13.3	316	3.1
4	200 (5)	4.6	3.8	17.3	479	3.5
5	200 (5)	4.3	3.5	15.1	384	2.9
6	200 (5)	4.1	4.2	17.2	308	2.7
7	333 (3)	3.7	3.2	11.7	650	4.3
8	333 (3)	3.8	3.8	14.3	570	3.8
9	250 (4)	2.8	3.9	10.9	324	3.6
10	250 (4)	2.4	3.9	9.4	355	3.8
11	250 (4)	2.3	4.3	9.8	297	4.4
12	250 (4)	2.4	4.0	9.6	361	3.9
13	250 (4)	2.5	4.5	11.0	350	3.8
14	250 (4)	2.3	4.4	10.1	312	3.6

**Table 3.** Properties of 2×2 rib fabrics from bouclé yarns according to Table 1.

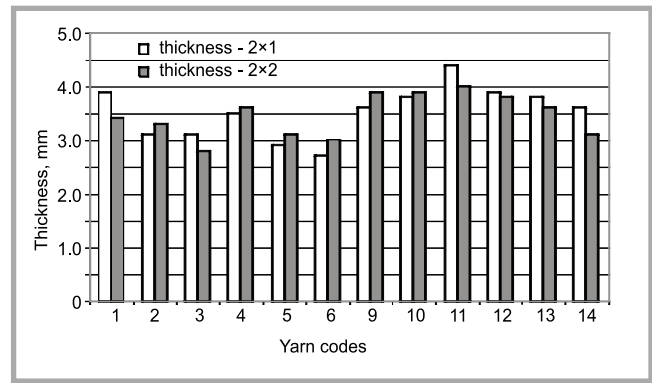
Yarn Code	Yarn count, tex (Nm)	Wales per cm	Courses per cm	Stitch density per cm <sup>2</sup>	Area weight, g/m <sup>2</sup>	Thickness, mm
1	200 (5)	4.2	3.8	15.8	395	3.4
2	200 (5)	3.4	4.2	14.3	353	3.3
3	200 (5)	2.6	4.3	11.1	256	2.8
4	200 (5)	4.4	4.0	17.6	466	3.6
5	200 (5)	3.7	3.8	13.9	353	3.1
6	200 (5)	3.6	4.7	16.9	277	3.0
7	333 (3)	3.7	3.3	12.2	669	4.4
8	333 (3)	3.0	4.4	13.2	540	3.5
9	250 (4)	2.4	4.6	11.0	331	3.9
10	252 (4)	2.2	4.1	8.9	322	3.9
11	250 (4)	2.2	4.3	9.1	301	4.0
12	250 (4)	1.9	3.3	6.2	336	3.8
13	250 (4)	2.0	4.6	9.2	324	3.6
14	250 (4)	2.2	4.7	10.3	365	3.1

pending on the overfeed ratio, changes in bouclé height are more effective than the twist direction of the yarns, since for each structure the wale density dramatically drops at 200% overfeed of the S and Z directions.

It was found that the stitch density of 2×1 rib fabrics was generally significantly higher than that of 2×2 fabrics at 95% level of confidence. This might be attributed to the fact that 2×1 rib fabrics tend to dry relax more easily than 2×2 rib fabrics,



**Figure 1.** Stitch density of 2x1 and 2x2 fabrics for yarn codes 1 ... 14; other fabric properties are listed in Tables 1 and 2.



**Figure 2.** Thickness of 2x1 and 2x2 fabrics for yarn codes 1 ... 14; other fabric properties are listed in Tables 1 and 2.

depending on the placement of the bouclé effects in the structures. Changes in the binding yarn twist amount do not seem to affect the fabrics' stitch density at all.

On the other hand, irrespective of the twist direction of bouclé yarns that have two-ply effect material, the stitch density of the fabrics from the bouclé yarns of 66 tex × 2 effect yarn count is lower than that of fabrics from yarns of 66 tex at 100% overfeed, whereas the results obtained at 200% overfeed are just the opposite. Accordingly, it seems that for the stitch density of the fabrics, the effect yarn count is as effective as the overfeed ratio.

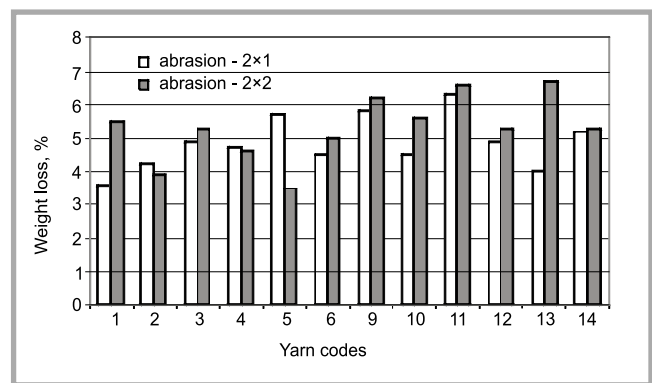
On the other hand, the differences in the weight of the fabrics studied can be attributed to the differences between the stitch densities and yarn counts.

The thickness of the fabrics was measured under 5-bar pressure. This pressure was set at a low level in order for the bouclé effects to retain their original form as

**Table 4.** Abrasion (weight loss%) of 2x1 rib knit (RK) and 2x2 rib knit (RK) fabrics from bouclé yarns.

Yarn Code	Weight loss, %	
	2x1 RK fabrics	2x2 RK fabrics
66tex/S/550/100	3.6	5.5
66tex/S/500/100	4.2	3.9
66tex/S/450/100	4.9	5.3
66tex/Z/550/100	4.7	4.6
66tex/Z/500/100	5.7	3.5
66tex/Z/450/100	4.5	5.0
66tex×2/S/500/100	1.5	2.9
66tex×2/Z/500/100	1.8	2.0
66tex/S/550/200	5.8	6.2
66tex/S/500/200	4.5	5.6
66tex/S/450/200	6.3	6.6
66tex/Z/550/200	4.9	5.3
66tex/Z/500/200	4.0	6.7
66tex/Z/450/200	5.2	5.3

**Figure 3.** Abrasion of 2x1 and 2x2 fabrics measured as percentage weight loss for yarn codes 1 ... 14 according to Table 1.



much as possible. It is observed that the thickness of both types of fabrics tends to increase when the overfeed ratio is increased from 100% to 200% (Figure 2), and the differences are found to be statistically significant. The effect of overfeed on the height of the effects discussed before is somehow reflected on the thickness values of the samples. The thickness of fabrics from S-twisted yarns tends to be higher than that of fabrics from Z-twisted ones. Although the maximum height of Z-twisted bouclé yarns are slightly higher than that of the S-twisted yarns, the higher number of bouclé effects in S twisted yarns was reflected more dominantly in the thickness values of 2x1 and 2x2 rib fabrics. A comparative study with the authors' previous work [4] reveals that effect height is not as influential as in the case of plain jersey and 1x1 rib fabrics so far as thickness is concerned. This may be because of the placement of bouclé effects in the samples, depending on the fabric structure. As the wale density values suggest, the bouclé height is not reflected in the thickness values, providing that the effects are located between the loops. Contrary to what was expected, as the binding yarn twist decreases, the thickness of the fabrics tends to decrease. From the results, it can also be seen that using coarser effect material in the yarn

results in the formation of thicker fabrics. The results suggest that binding yarn twist may influence the thickness of the fabrics to some extent, though a more detailed study should be conducted using wider binding yarn twist ranges.

The results of the abrasion tests are presented in Table 4. The abrasion tests gave the following results:

Irrespective of fabric structure, there are statistically significant differences between the weight loss of the fabrics which were knitted from bouclé yarns at 100% and 200% overfeed ratios after abrasion tests (Figure 3). This might be attributed to the fact that yarns produced at 200% overfeed have a higher maximum effect height than those produced at 100% overfeed. On the other hand, as a general tendency, the weight loss of fabrics from Z-twisted yarns seems to be lower. Although maximum effect height in Z-twisted yarns is higher than that of the S-twisted ones, the difference is not as great as that observed between the relevant yarns produced at 100% and 200% overfeeds. Besides, the effect number is lower in Z-twisted yarns. This might be the reason for the relatively higher abrasion resistance observed in the fabrics from Z-twisted yarns.

The abrasion resistance of 2×2 rib structures seems to be lower than that of 2×1 rib fabrics. This result can be attributed to the higher stitch density of 2×1 rib fabrics when compared with the 2×2 rib ones.

It is also observed that using the coarser effect material results in a considerable decrease in the weight loss of fabrics after abrasion. This may be partially due to the higher initial weight of the samples. More samples in the effect material may also increase the cohesion between fibres.

According to the results obtained, 2×1 rib structures tend to dry-relax more easily than 2×2 rib structures, and they show better abrasion resistance. However, the effects of using coarser effect material in bouclé yarns should be studied in detail, as fabrics from bouclé yarns that have coarser effect material are thicker and more resistant to abrasion.

A comparative study of the surfaces of 2×2 and 2×1 rib fabrics reveals that unlike plain jersey fabrics, the bouclé effect is more uniformly distributed on both the technical face and back of the rib fabrics. This enhances the attractiveness of fabrics made from bouclé yarns. Taking the results discussed in the paper into consideration, employing bouclé yarns in 2×1 rib structures could be suggested.

## Conclusions

In this paper, the properties of 2×1 and 2×2 rib fabrics made from bouclé yarns have been studied. Some physical properties of the samples produced using these yarns were tested in accordance with the relevant standards. A comparative study of the results showed that:

- the stitch density of fabrics knitted with yarns of 200% overfeed was lower than that of fabrics knitted with yarns of 100% overfeed for both fabric types.
- the stitch density of fabrics from S-twisted yarns tends to be lower than that of the fabrics from Z-twisted yarns, whereas the stitch density of 2×1 rib fabrics was higher than that of 2×2 fabrics.
- as could be assumed:
  - the thickness of both types of fabrics tends to increase when the overfeed ratio is increased from 100% to 200%.
  - using coarser effect material in the yarn results in the formation of thicker fabrics.

- the thickness of fabrics from S-twisted yarns tends to be higher than that of the fabrics from Z-twisted ones.
- fabrics knitted from bouclé yarns at 200% overfeed give the highest weight loss after abrasion tests.
- the weight loss of fabrics from Z-twisted yarns seems to be lower.
- the abrasion resistance of 2×2 rib structures seems to be lower than that of 2×1 rib fabrics.
- the results obtained imply that the binding twist of bouclé yarns does affect some properties of fabrics knitted from these yarns, although the binding twist range selected for the work does not seem wide enough to reach concrete conclusions.

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