PICK SPREADING WITH SPECIFIC REFERENCE TO SET MARKS

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This paper investigates the deformation of weft yarn in the set-mark region resulting from variations in the beat-up intensity. Twistless multifilament weft yarn tends to spread over open spaces and can be conducive to some extent to concealing pickspacing variation.

1. INTRODUCTION

During normal weaving, mechanical conditioning of the warp, fabric and machine components play an important role in generating uniform beat-up intensity to ensure regular pickspacing. The last pick is beaten with insufficient intensity, let the loom be stopped during beat-up. Similarly, at start-up the acceleration of the reed introduces variation in the initial beat-up intensity depending upon the loom starting position. Set mark in the woven fabric originates from interrupted weaving as a short term pickspacing variation.

Loom dynamics and/or visco-elastic nature of the warp and fabric play an important part in the formation of set marks. Though today's weaving machines incorporate many refinements to assure fabric quality, the effective elimination of set mark has to be achieved particularly in high speed weaving. Twistless multifilament weft yarns are likely to be more prone to spreading over open spaces, and is investigated with specific reference to set marks.

2. EXPERIMENTAL SET-UP

A Saurer narrow loom Model 60 B was used to weave plain lining fabric 35 epc × 24.5 ppc from warp and weft of dtex 167/42 regular viscose at 310 picks/min with a warp tension 2~2.5 cN/tex. The reference fabric samples were produced during normal weaving. 10 samples were randomly selected for analysis from a single piece of fabric, woven at constant settings. Seven consecutive picks from each sample were measured at random and averaged to obtain reference data.

To produce set marks each time the loom was stopped for 60 s at the closed shed position (315°) and started from the same position. The samples were measured at five positions across the width of the fabric over eight picks from two picks before the loom stoppage to five picks after start-up. Five stoppages were investigated for each set of experiments comprising 200 individual measurements. Projection microscope, Scanning Electron Microscope SEM and Quantimet Image Analysis techniques were used for physical measuring, feature identifications and analysis.

2.1 Pick Diameter and Pickspacings

The pickspacing and pick diameter at each weaving cycle for each of the five stops show a very similar trend, so it is permissible to average them to produce the mean trends. The deviation from the reference mean is greatest at the stop point in both cases. Pick spreading is pronounced in the region of set marks. Loose structural cohesiveness of twistless multifilament filling yarn is found to be conducive to spreading over the open spaces across the set mark.

2.1.1 Pick Spacing

The deviations of the mean pickspacings at each weaving cycle from the reference overall mean pickspacing are shown in Fig. 1 and Table 1. Positive deviations indicate the presence of an open space and negative deviations indicate a dense space in the fabric. Two features of this graph are immediately apparent:

❶ The deviation from the overall mean at the stop position is much greater than at any other position. This could be the loom dynamics that influence greatly the initial start-up phase.

❷ The deviations before and at the stop tend to be positive. After the stop they tend to be negative, though much smaller in magnitude.

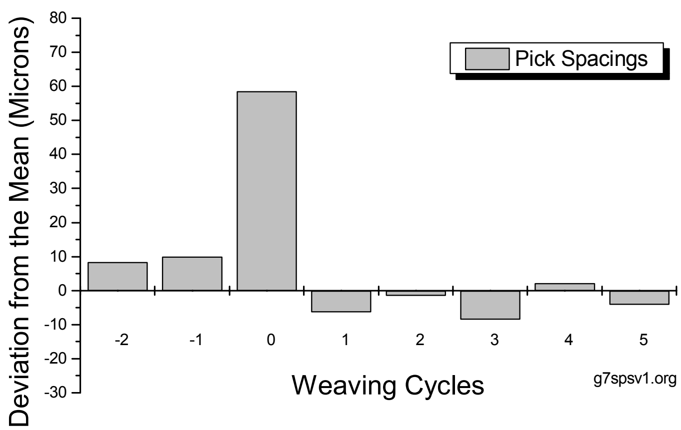


Fig. 1 Deviation of pickspacings across the set mark

This may be as a result of the pick slipping back and loom dynamics. Once weaving is resumed the warp yarns recover the instantaneous and time dependent extension that they underwent during a stoppage, thus possibly increasing pick density locally, which gradually shades away until an equilibrium state is achieved.

An example of model of data is $x_{ijk} = \mu + P_i + Q_j + (P \times Q)_{ij} + \varepsilon_{ijk}$ ... ... (1)

where μ is the population mean, which is constant, P_i is the effect of the *ith* pick (i = -2, -1, ..., ..., 5), Q_j is the effect of the *jth* position (j = 1, 2, ..., ..., 5), k = replicate number (k = 1, 2, ..., ..., 5), and ε_{ijk} = experimental error.

Table 1 Overall mean deviations of pickspacings in the region of set marks

Weaving cycles	-2	-1	0	1	2	3	4	5
Overall mean deviations μ m	8.3	10.0	58.5	-6.2	-1.4	-8.4	2.2	-4.1
Overall mean deviations %	2.03	2.45	14.34	-1.52	-0.34	-2.06	0.54	-1.01

The deviations around the stop (at cycles -2, -1, 0, 1) are statistically significant. Beyond this, they tend to be not significant though the deviation at cycle 3 is an exception. It is not clear why this should be so, as one would expect the deviations at these and later cycles to tend towards zero, as the weaving returns to normal after the stop.

2.1.2 Pick Diameter

Fig. 2 shows the deviations of the mean pick diameters at each pick from the reference overall mean pick diameter. Again, two features of this graph are distinctly apparent.

✡ The deviations before and at the stop tend to be positive. After the start-up they tend to shade away as the normal weaving condition is restored.

✡ The deviation from the overall reference mean at the stop position is greater than at any other position.

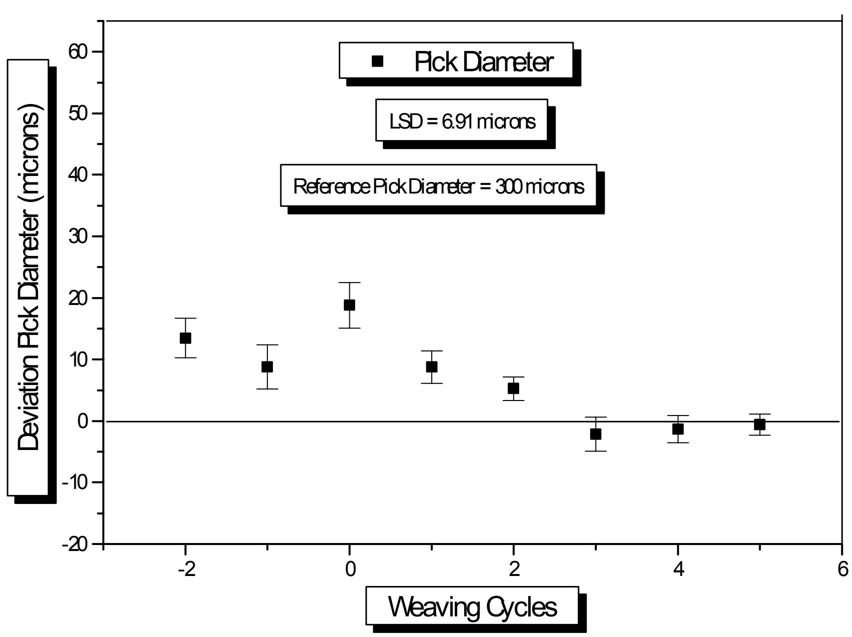


Fig. 2 Variation of pick diameter across the set mark region

Table 2 shows the difference between consecutive pick means. The differences around the stop are significant, the difference between picks 2 & 3 is just significant. When pick mean diameter of the stop point is compared with other pick means it becomes apparent that most of the differences are significant with an exception between pick 0 & -2. This is shown in Table 3. These differences are, however, small and would probably not be noticeable to the human eye.

Table 2 Difference among mean of pick diameter in the region of set marks

Between picks	-2 & -1	-1 & 0	0 & 1	1 & 2	2 & 3	3 & 4	4 & 5
Difference between picks µm	4.7	10.0	10.0	3.5	7.4	0.8	0.7

The pick has a tendency to spread in the stop and start phase of the weaving. The possible reasons for this could be the deceleration during a stop leading to a smaller beat-up force and similarly the inertia of the reed during a start would lead to a smaller compression force to beat the pick. This permits the twistless multifilaments weft yarn to spread considerably. When the machine starts again, the first pick to be beaten up, pick 0, is again subjected to a smaller beat-up force than subsequent picks because the machine has not at this stage reached full speed. Pick slipping back at the cloth fell also may enhance pick spreading. The pick diameter gradually returns to its normal value as the normal weaving speed is restored.

Table 3 Difference among mean pick dia. from the stop point of set marks

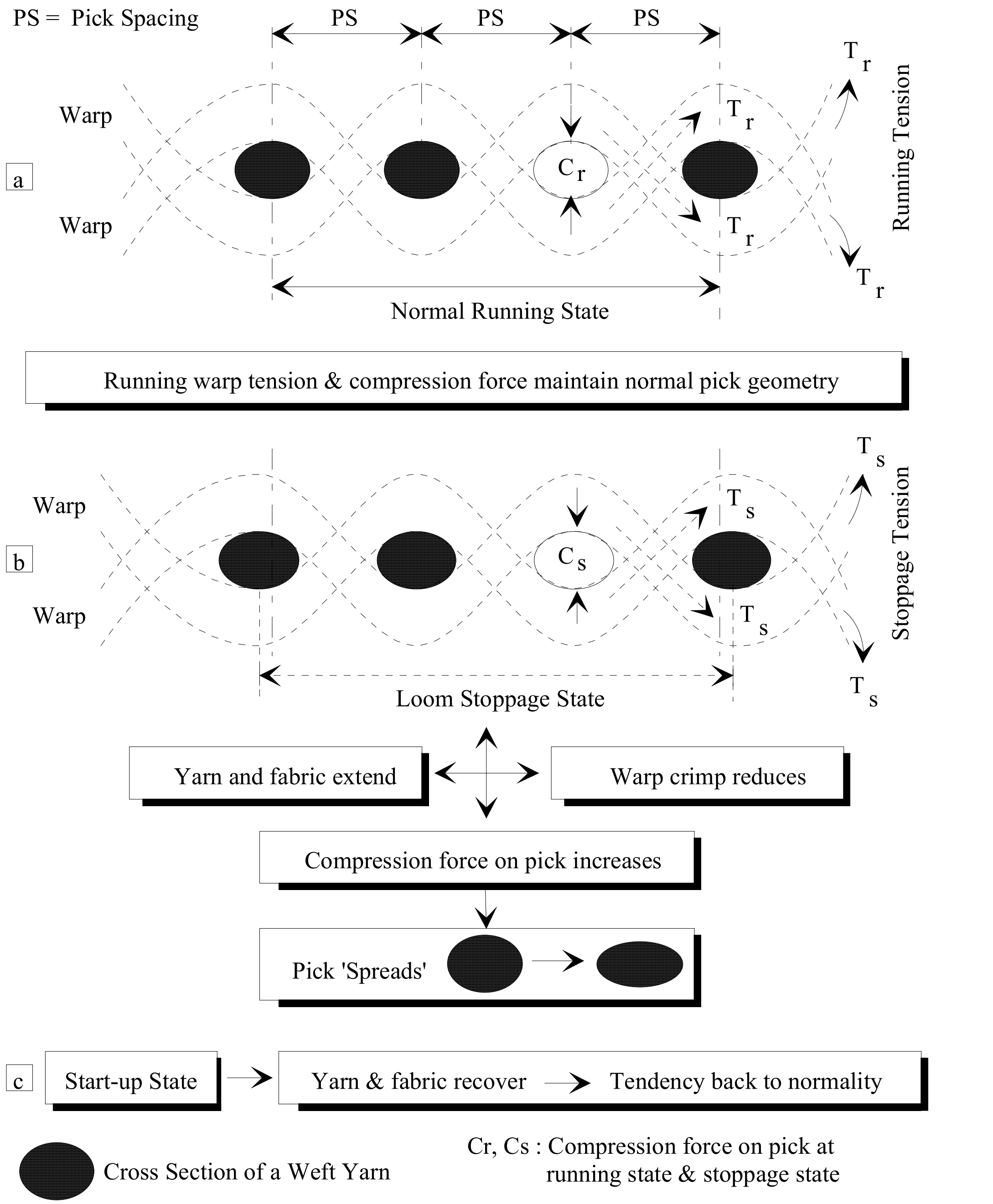
Between picks	0 & -2	0 & -1	0 & 1	0 & 2	0 & 3	0 & 4	0 & 5
Difference between picks µm	5.3	10.0	10.0	13.5	20.9	20.1	19.4

Table 4 Overall mean deviations of pick diameter in the region of set marks

Weaving cycle	-2	-1	0	1	2	3	4	5
Overall mean deviations µm	13.5	8.8	18.8	8.8	5.3	-2.1	-1.3	-0.6
Overall mean deviations %	4.50	2.93	6.27	2.93	1.78	-0.7	-0.43	-0.2

In Table 4, the deviations around the stop (at cycles -2, -1, 0, 1) are significant. Beyond this, they tend to be not significant; one would expect the deviations at these and later cycles to be tending towards zero, as the weaving returns to normal after the stop.

As the normal weaving speed is restored, a trend is noticed; the pick diameter reduces initially and then gets back to its normal value (Fig. 2). During a loom stoppage both the warp and fabric are deformed and extended with time due to creep. The spring loaded back rail maintains a constant warp tension at the expense of time dependent extension of the warp yarns and the fabric. When the loom is started-up and weaving is resumed the extended warp and fabric tends to recover with time. The deviation of pick diameter across the set mark region can be explained by an analytical approach, illustrated in Fig. 3, which has the following features:



(a) Normal running condition, when weaving machine is operated fault-free
(b) Effect of time dependent extension at stop phase due to creep
(c) Effect of recovery at start-up phase due to resumption of cyclic operation

Fig. 3 Exaggeration of yarn deformation due to creep and its implication on pick diameter and spacing

❍ During normal running the yarn and fabric tension (T_r) and the compression force on the picks (C_r) maintain a uniform pick geometry.

❍ During a loom stoppage the geometry of the twistless multifilament weft yarn is deformed by a number of factors:

- yarn and fabric is subject to stop tension (T_s) and creep takes place, i.e. fabric and yarn extend slightly,
- thus warp crimp reduces,
- the compression force on the picks (C_s) increases,
- as a result of which the pick 'spreads'.

Moreover, it is probable that the deceleration of the reed during a loom stoppage generates a smaller beat-up force and this may also lead to pick spreading. This dominates the stop phase of the set mark region (Fig. 2).

❍ At the start-up phase both the warp yarns and the fabric recover with the resumption of cyclic operation and tend back to normality as the normal running condition is restored. This dominates the start-up phase of the set mark region (Fig. 1, 2).

The factors that influence the relaxation and recovery also have an influence on the trend. This trend is presumably more pronounced in the case of warp yarns.

3. DISCUSSION

The analyses described above have highlighted some of the significant effects on thread spacing and thread diameter when a loom stoppage occurs. The knowledge thus gained has been used to describe procedures that are designed to reduce the occurrence of set marks [Islam, Doctoral Thesis 1996, School of Textile Industries, University of Leeds]. Further, it appears that loose cohesiveness of the yarn structure is susceptible to spreading over an open space in the region of set marks. This could be considered conducive to concealment of the fault to a certain extent.

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