STASTICAL ANALYSIS OF SOME LOOM PARAMETERS AFFECTING YARN STOPS ON AIR JET LOOM

by

Dr. Mahmoud Salama
Dep. of Textile Eng., Faculty of Eng. Mansoura University

تحليل إحصائى لبعض عوامل النول المؤثرة على وقفات الخيوط على أنوال دفع الهواء

خلاصة :

فى هذا البحث تم استخدام التجارب متعددة العوامل لبحث تأثير بعض عوامل النول على وقفات النول أثناء النسيج والناتجة عن خيوط السدا واللحمة.

هذه العوامل هى : توقيت تبادل الدرأ وسرعة الماكينة ووضع المسند الخلفى وقد بين التحليل الإحصائى أن وقفات السدا واللحمة أثناء النسيج على أنوال دفع الهواء تتأثر معنويا بهذه العوامل. وقد وجد ان التداخل بين هذه العوامل له تأثير كبير على وقفات الخيوط ولقد تم عمل هذا التحليل الإحصائى لوقفات الخيوط على انوال دفع الهواء طراز بيكانول وتسودوكوما بغرض المقارنة.

Abstract

In this work , the factorial design technique was used to investigate the influence of some loom parameters on the yarn stops during weaving on air jet loom. These parameters are the timing of harnesses crossing, machine speed and position of back beam. The statistical analysis showed that the warp and weft stops are significantly affected by these parameters. The interaction between these parameters had a large influence on the yarn stops. The analysis of yarn stops was done on Picanol and Tsudokoma air jet looms for comparison.

1-Introduction

Generally, the productivity of a weaving machine is highly affected by the number of stops due to warp and weft stops. With the high speed weaving machines, where the cost of machine is also high, the economics of the weaving processe depends , to a large extent, on the productivity of the weaving machine. In case of air jet weaving, the weft is inserted by means of an air stream through the the warp shed. The main air nozzle ejects the main air stream requried for insertion and the relay nozzles help the main nozzle in keeping the weft yarn straight for a large distance, i.e. loom width. A clean warp shed is required to prevent clinging of the weft with the warp during insertion. The matter which will reduce the weft stops. The hariness of the warp is expected to have a large influence on warp entanglment during shed formation. In spit of the fact that a well prepared warp is an essential requirment for high speed air jet weaving(up to 1200 p.p.m.). There are some parameters on the weaving machine which affects the level of the warp and weft tension as well as the entanglment of warp during weaving. The matter which may cause a yarn break, and hence the machine stops. The speed of the weaving machine is expected to have a large influence on both warp and weft tension during weaving. However, it has been shown [1] that level of warp tension was slightly increased when the speed of a repiar weaving

machine increased up to 400 p.p.m. Also, the measurement of the beat up force on a water jet loom [2] showed that varing the loom speed over the range 298-391 p.p.m. did not affect the beat up force. The warp abrasion during weaving was found to be affected by the machine speed [3]. The yarn strength reduced rmarkably due to abrasion, the matter which affected the number of stops on the weaving machine. The warp entanglment in the back shed was found to be the main cause of warp breaks. It was found [4] that the majority of warp breaks during weaving arised from abnormal tension developed in small groups of threads, which resulted from obstractions caused by knots, slubs, neps,..ets. The increase in the vertical distance between heald eyes in adjacent staves reduced the obstractions at shed crossing which resulted in a reduction in warp breaks [5]. Also, the increase in the level of warp tension increased the number of warp breaks.
The shed geometry [6] in terms of the position of the back beam relative to the fell of the fabric, was found to have a large influence on the level of warp tension , entanglment of warp threads , and warp and weft stops during weaving. The unsymetrical shed reduced the number of weft and warp stops during weaving on air jet loom.
The measurement of the beat up force [2] showed that the shed timing had no effect on beat up force. The matter which disagreed with the majority of the puplished results. It was said that crossing the harnesses earlier resulted in a high warp tension at beat up and this depends on the weft yarn. In earlier work [7] it was found that the timing of harnesses crossing had a large influence on the warp and weft stops during weaving on air jet loom. It was also found [8] that in the case of looms having neither sley nor heald dwells, the early harnesses crossing resulted in an unobstracted shed for weft insertion and the effective shed size could be made smaller.

The aim of this work is to use the factorial design technique to analize some parameters affecting the warp and weft stops during weaving on air jet loom. The parameters which considerd are:

1-weaving machine speed,
2-position of back beam relative to fell of fabric, and
3-timing of harnesses crossing.

This will lead to a better understanding to the influence of each parameter on the warp and weft stops, and also the interaction between these parameters is domenstrated.
The work in this study was carried out on two air jet looms, Picanol and Tsudakoma, weaving the same fabric in an industrial running conditions. This is to compare between these machines in terms of th warp and weft stops.

2-Specifictions of weaving machines

The two air jet weaving machines which were considered in this study are : Picanol PAT and Tsudakoma TS-ZA. The two machines were running at Misr Spinning and Weaving Co., Mehalla Kubra in the industrial running conditions, as showen in Table(1).

Table (1) weaving machines and fabric specifications

	Picanol PAT	Tsudakoma TS-ZA
Loom Speed, p.p.m	640 - 644	617 - 620
Reed width, cm	171	171
Shedding	4 Shaft-Cam	4 Shaft-Cam
weft Insertion:	main nozzle, relay nozzles and fixed nozzle	main nozzle and relay nozzles
Fabric =	plain Cotton 40 x 40 15 x 15 110 x 72 44 x 29 162 cm	plain Cotton 40 x 40 15 x 15 110 x 72 44 x 29 162 cm
Sley Mechanism	5 - link	4 - link
Supply Air pressure, bar:		
main nozzle	2.5	5.2
relay nozzles	3.0	6.0

Table (2) Independent parameters and Selected levels

Independent Parameters	level	- 1		0		- 2	
		PAT	TS	PAT	TS	PAT	TS
$X_{1)}$ timing of crossing deg.		300	270	320	280	340	290
$X_{2)}$ machine Speed, p.p.m		620	590	640	620	660	650
$X_{3)}$ back beam position		9.5	75	10	80	10.5	85

3-Experimintal design

The experimental plan was made according to the factorial design technique to investigate the effect of machine speed, position of back beam and harnesses crossing angle on the number of weft and warp stops. This technique of experimental design is useful to investigate the interaction between the different parameters. For each independent parameter, three levels were selected. The independent parameters and the levels are shown in Table(2) for both weaving machines.

4-Statistical analysis

Table(3) shows the factorial design of experiments and results obtained for weft and warp stops per 10^5 picks(cmpx). The average number of warp and weft stops per cmpx were recorded after a running time of 4-5 hrs. for each experiment. This was important to run the whole experimental plan using a single warp beam per machine to avoide the variation which may occure between warp beams.
A statistical computer program was used to determine the parameters and the interactions between parameters that affects the weft and warp stops. The multiple linear regression was used to caculate the emperical relationships between the independent parameters and the warp and weft stops per cmpx.

The values given in Table(4) are the estimates of the coefficients (b_i) of the parameters for relationships such as:

$$E(Y)=b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_1X_2+b_5X_1X_3+b_6X_2X_3+b_7X_1^2+b_8X_2^2+b_9X_3^2$$

Where E(Y) is the expected value of the output variable (weft stops or warp stops per cmpx) using the experimental results. The X_1 , X_2 and X_3 values are the coded values of the input parameters.

5-Discussion of results

The effect of the timing of harnesses crossing, machine speed and position of back beam on the warp and weft stops per 10^5 picks(cmpx) are shown in Figures(1 to 6).

5.1.Warp stops per 10^5 picks(cmpx)

The contour lines of warp stops on TS air jet loom show that the warp stops is affected by the machine speed, position of back beam and timing of harnesses crossing, as shown in Figure(1). Generally, the increase in machine speed increased the number of warp stops and this was largely influenced by the timing of harnesses crossing. The earily harnesses crossing reduced the number of warp stops. Also, the contour lines show that the warp stops increased as the position of the back beam was raised up to position 80. Then, decreased when the beam was rasied to position 85. This happened at low and high machine speed and was not affected by the timing of harnesses crossing. This is attributed to the difference betweent the warp tension in top and bottom shed which resulted from the position of the back beam relative to the fell of the fabric[6].

Table (3) Factorial design of experiments and results

Exp. No.	X_1	X_2	X_3	PAT		TS	
				warp stops per. cmpx	weft stops per cmpx	warp stops per cmpx	weft stops per cmpx
1	0	+	−	11	2.5	1.3	15.6
2	0	−	+	8.3	2.3	2.6	13.8
3	0	+	+	9	7	2.6	8.6
4	0	−	−	7	3	0.8	5.2
5	+	0	+	6	12	1.3	9.1
6	−	0	−	6	6	1.56	18.2
7	−	0	+	4	5	1.56	6.5
8	+	0	−	4	13	3.4	12
9	+	+	0	9	7	7.8	22
10	−	−	0	5	4	2.6	7.8
11	−	+	0	6	6	2.6	17
12	+	−	0	5	10	3.9	3.9
13	0	0	0	5	7	5.4	8

Table (4) Emprical relationship from experimental results

Coefficient	Estimates of Coefficients			
	PAT		TS	
	warp stops	weft stops	warp stops	weft stops
b_0	5	7	5.4	8
b_1	.375	2.625	1.01	−.3125
b_2	1.2125	.4	.55	4.0625
b_3	−.0875	.225	.125	−1.625
b_4	.75	−1.25	.975	2.225
b_5	1	0	−.525	2.2
b_6	−.825	1.3	−.125	−3.9
b_7	−1.2875	2.525	−.5225	2.6625
b_8	2.5375	−2.775	−.6525	2.0125
b_9	1.2875	−0.525	−2.9225	.7875
Correlation Coefficient	.99	−	.91	.86

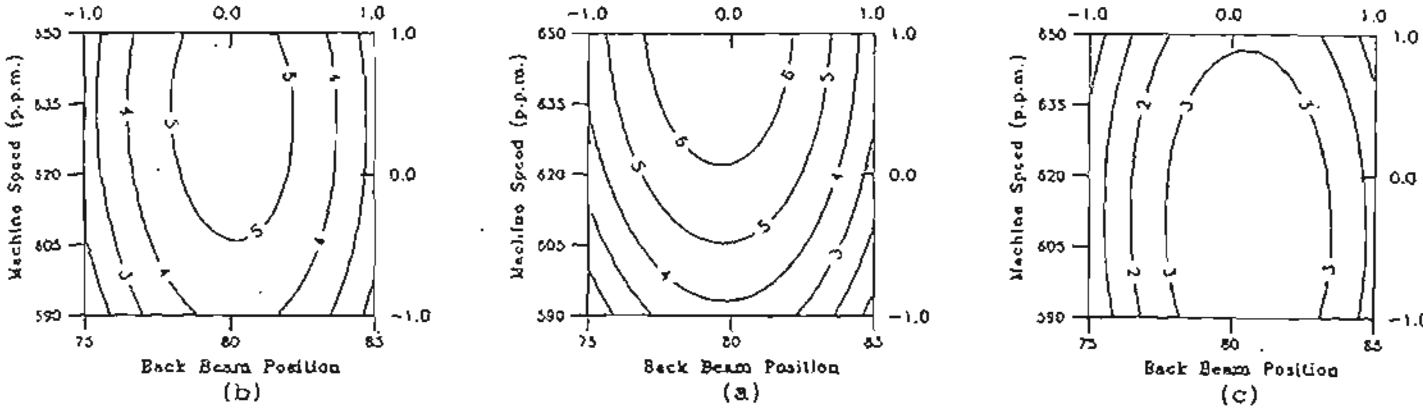


Figure (1) contour lines of warp stops per 10^5 picks on TS loom at crossing a) 270° b) 280° c) 290°

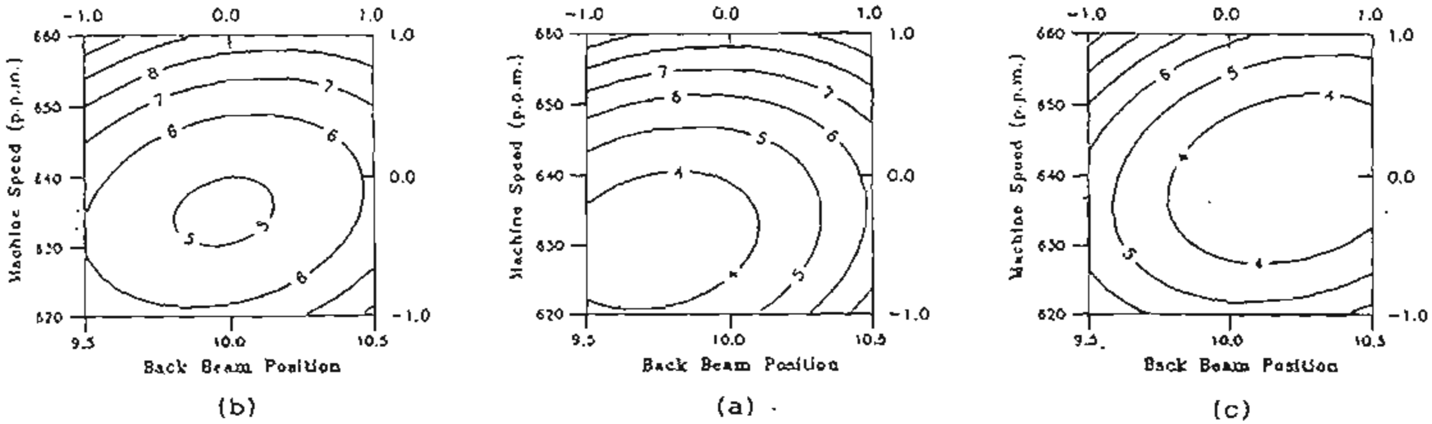


Figure (2) contour lines of warp stops per 10^5 picks on PAT loom at crossing a) 300° b) 320° c) 340°

The contour lines of warp stops on PAT air jet loom, shown in Figure(2), show that the warp stops is largly affected by the machine speed, position of back beam and timing of harnesses crossing. Although, the increase in machine speed resulted in an increase in warp stops. The position of back beam and timing of harnesses crossing determined the level of warp stops. The high position of back beam, up to 10.5 and earily harnesses crossing of 300° reduced the warp stops. The contour lines in Figure(2), show an optimum running conditions for PAT air jet loom to get a minimum warp stops.
Inspit of the fact that the warp inclination angle on TS loom is smaller than that on PAT loom, as shown in Table(5), and the TS loom utilizes an electronic let-off mechanism. The difference in the level of warp stops between these loom was not large.

5.2.Weft stops per 10^5 picks(cmpx)

Figure (3) shows the the contour lines of weft stops on TS loom. The weft stops increased as the machine speed was increased. The position of back beam and timing of harnesses crossing played an important rule in determining the weft stops. At high machine speed the weft stops went down when the position of back beam was raised to 85. This is attributed to the less warp entanglment during shedding as a result of the difference in warp tension between the top and bottom shed positions[6]. The earily harnesses crossing resulted in a remarkable reduction in weft stops(from 290° to 280°). This is because the early harnesses crossing resulted in an unobstracted warp shed for weft insertion[8]. This reduced the possibility of weft clinging with the warp during insertion. The matter which made the weft stops went down.
Figure(4) shows the contour lines of weft stops on PAT air jet loom. In this case, the weft stops went up as the machine speed was increased, and then went down as the speed was further increased to 660 p.p.m. The change in the timing of harnesses crossing from 340° to 320° resulted in a remarkable decrease in weft stops. The back beam position affected the weft stops. At low machine speed, the weft stops went down as the position of back beam was rasied to 10.5, the opposit occured at high machine speed.

The level of weft stops on TS loom was observed to be relatively higher than that on PAT loom. This is attributed to the type of sley motion on TS loom. Although the strok of the sley on TS loom is nearly 36% longer than that of PAT. The change in the shed size on TS during insertion is expected to be larger than on PAT loom.

Figures(5 & 6) show the response surface equations of warp and weft stops per cmpx on the TS and PAT looms.

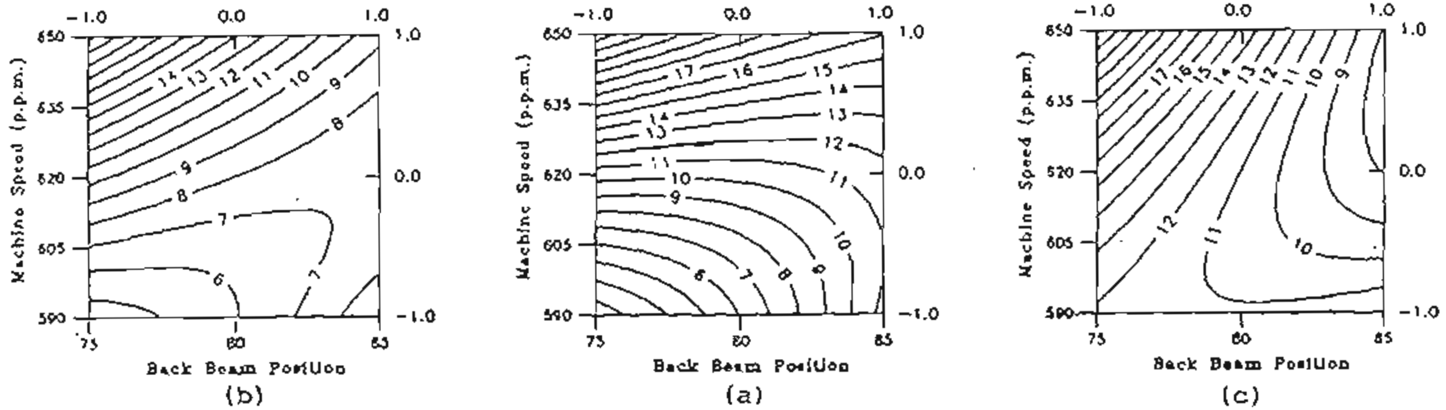


Figure (3) Contour lines of weft stops per 10^5 picks on TS loom at crossing a) 270° b) 280° c) 290°

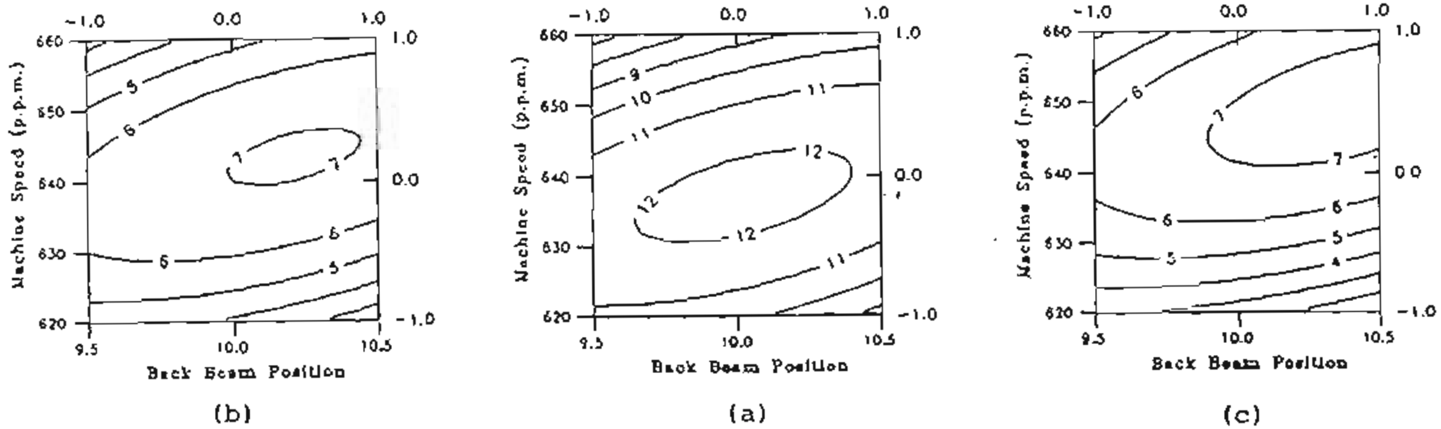
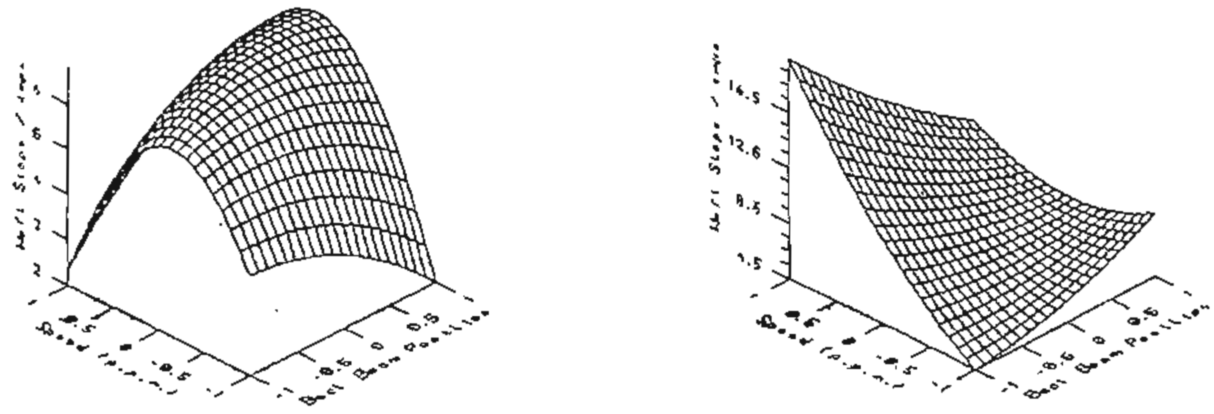


Figure (4) Contour lines of weft stops per 10^5 picks on PAT loom at crossing a) 300° b) 320° c) 340°

Table (5) The warp inclination angle to horizontal Corrosponiding to back beam position

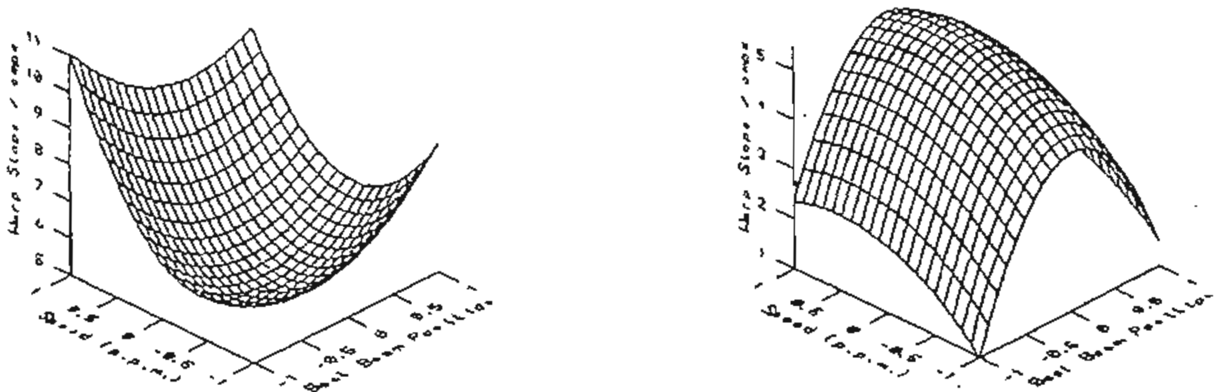
Picanol PAT		Tsudukoma TS	
Back beam position *	Inclination of warp, θ°	Back beam position *	Inclination of warp, θ°
9.5	8.1	75	4.5
10.0	8.4	80	4.8
10.5	8.7	85	5.0

* Positions are marked on the machines



(a) (b)

Figure (5) Response surface equation of weft stops
a) PAT loom (320°) b) TS loom (280°)



(a) (b)

Figure (6) Response surface equation of warp stops
a) PAT loom (320°) b) TS loom (280°)

6-Conclusions

The previous analysis showed that, on air jet loom the warp and weft stops are affected by machine speed, back beam position and timing of harnesses crossing. The interaction between these parameters is important and must be considered if it is requried to increase the loom productivity. The high position of back beam(up to a certain value) showed a positive influence on the warp and weft stops at high machine speed. In this case a back beam position of 85 (5° warp inclination angle) and harnesses crossing at 270° at a machine speed of 650 p.p.m., showed to be a good running conditions for TS loom. On the PAT loom a back beam position of 10.5 (8.7° warp inclination angle) and harnesses crossing at 320° at machine speed of 660 p.p.m. showed to be a good running conditions.

7-References

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