

5-23-2021

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Recommended Citation

Shaheen, Ahmed (2021) "Factors Affecting Weft Stresses on Shuttleless Weaving Machines.," *Mansoura Engineering Journal*: Vol. 15 : Iss. 2 , Article 26.

Available at: <https://doi.org/10.21608/bfemu.2021.171476>

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FACTORS AFFECTING WEFT STRESSES ON SHUTTLELESS WEAVING MACHINES

by
Ahaed Shaheen

العوامل المؤثرة على اجهاد خيوط اللحمة على ماكينات النسيج اللامكوكية

الخلاصة: في هذا البحث تم قياس اجهاد خيوط اللحمة أثناء قذفها على الثلاثة أنواع الرئيسية من ماكينات النسيج اللامكوكية وهي :
ماكينات النسيج ذات القذف الهوائي
ماكينات النسيج ذات الشريط (رابير)
وتم دراسة تأثير العوامل التالية على التغير في قيمة اجهادات خيوط اللحمة
معدل القذف لخيوط اللحمة (متر في الدقيقة) - الكثافة الطولية لخيوط اللحمة (جرام للسنتر)
معامل المرونة لخيوط اللحمة (مثنى نيوتن لكل تكس)
وقد استخدمت طريقة تصميم التجارب لتحديد مدى تأثير كل من العوامل السابقة على مقدار التغير في قيمة اجهاد خيوط اللحمة . حيث تم اعتبار كل من معدل قذف خيوط اللحمة ومعامل المرونة له كعاملين مستقلين ، وأعتبر التغير في شد خيوط اللحمة كعامل تابع يوجد أن معامل المرونة له تأثير فعال عند القذف على الماكينات ذات وسيلة القذف الميكانيكي أما بالنسبة لماكينات النسيج ذات القذف الهوائي فيكون التأثير الفعال على اجهاد خيوط اللحمة هو معدل قذف الخيط .

ABSTRACT

In this work the weft stresses were measured during picking on the following high production weaving machines:

Air jet weaving machine,
Projectile weaving machine,
Rapiet weaving machine .

The weft stresses were measured during picking on the different types of weaving machines under the effect of the following parameters:

- weft insertion rate in (m/min).
- modulus of elasticity of weft threads in (cN/tex).
- longitudinal density of weft threads in (g/m).

The experimental design methods were used to determine the parameters which have the main effect on the variation in weft tension, by considering the weft insertion rate and the modulus of elasticity of weft threads as independent variables and the variation in weft tension as a dependent variable. It was found that the values of weft tension are affected by the latter parameters specially the weft insertion rate and modulus of elasticity of weft threads.

INTRODUCTION

The weft insertion rate in (m/min) of weaving machines (picks/min x machine width in meters) represents the productivity of the machine. The degree of weft stresses is affected by the increase in the weft insertion rate and this tend to an increase in the rate of weft breaks /8/.

By picking on rapier and projectile weaving machines (mechanical weft insertion) the maximum value of weft tension is due to accelerating the weft thread from its steady state up to the insantaneous speed of the picking element /2/,/3/ and /4/. And by picking on air jet weaving machine (pneumatic weft insertion) the maximum value of weft tension is due to stopping the inserted weft thread at the end of the picking time /1/ and /7/.

The characteristic of weft thread affect the value of weft tension, as shown in /6/ by picking on the weaving machines with mechanical weft insertion systems the value of weft tension is low for waxed weft threads than the raw threads.

By picking on air jet weaving machines the value of weft tension increases with increasing the air pressure of the main- and multi-nozzels, and the picking time is affected by many parameters such as:

- air pressure of the nozzels
 - hairness of weft threads
 - longitudinal density of weft
 - weft thread finishing
 - twist factor of weft thread
 - package diameter
- /5/,/9/ and /10/.

In this paper precise measurments of weft tension values during picking on the three shuttleless weaving machines under the effect of weft insertion rate, modulus of elasticity of weft thread and longitudinal density of weft threads.

EXPERIMENTAL

1- Specification of weaving machines and material used

- Rapier weaving machine.....up to 500 picks/min and 2 m cloth width
- Projectile weaving machine.....up to 350 picks/min and 2x2 m cloth width
- Air jet weaving machine.....up to 850 picks/min and 2 m cloth width
- Ends/cm.....47, cotton Ne 50/1
- Picks/cm.....28, cotton Ne 50/1 and 80/1
- Fabric structure.....Plain weave

2- Instrumentaion of weft tension measurments

Fig. 1 shows the arrangement of the apparatus used to measure the weft tension by picking on the three weaving machines, a measuring head 1 (RES,31 KHZ-eigenfrequency) was used to measure the value of weft tension. The signal is then fed to an amplifier 2 of 500 KHZ scan frequency and the signal could be accumulated and stored in a Hioki-apparatus 3, then finally the signal could be plotted with the suitable speed using plotter 4.

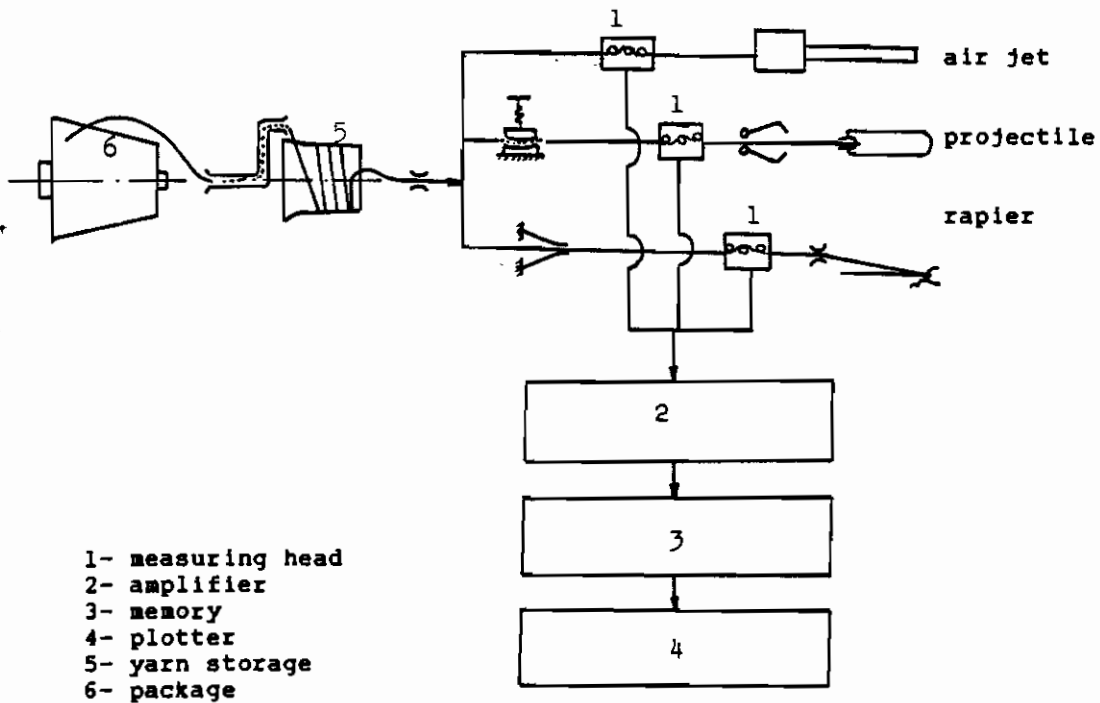


Fig 1 Arrangement of the measuring instruments

3- Experimental procedure and evaluation of results

During the normal weaving process the weft tension was measured at the picking on the three types of weaving machines. Fig 2 shows a typical signal of weft tension for the different picking systems. The maximum value of weft tension for the mechanical weft insertion (rapier and projectile) is due to accelerating the weft thread from steady state, but at pneumatic weft insertion (air jet weaving machine) the maximum weft tension is due to stopping the weft thread at the end of weft insertion time.

At every weaving machine speed fifty successive signals of weft tension were recorded for the different types of weft materials. The mean value of the maximum weft tension for the fifty signals could be calculated.

The results could be analysed and explained by using the experimental design methods as follows:

by using $(3)^2$ factorial experiment and the variable levels are:

X1 = weft insertion rate in(m/min)

and

X2 = modulus of elasticity of weft thread in(cN/tex)

The values of the variable X1 in(m/min) are:

	-1	0	1
rapier weaving machine	400x2	450x2	500x2
projectile weaving machine	330x2x2	340x2x2	350x2x2
air jet weaving machine	650x2	750x2	850x2

and the values of the variable X2 in cN/tex are:

	-1	0	1
modulus of elasticity of weft thread,cotton Ne 50/1	360	419	479
modulus of elasticity of weft thread,cotton Ne 80/1	430	483	537

Then the combination of experiments for every weaving machine could be arranged as follows:

experiment No.	X1	X2
1	-1	-1
2	0	-1
3	1	-1
4	-1	0
5	0	0
6	1	0
7	-1	1
8	0	1
9	1	1

From the calculations the equations which describe the response surfaces for the different weaving machines are:

Rapier weaving machine:

$$Y(\text{Ne } 50/1) = 49.25 + 1.1 X_1 + 2.78 X_2 - 0.733 X_1^2 - 0.483 X_2^2 + 0.625 X_1 X_2$$

$$Y(\text{Ne } 80/1) = 34.08 + 0.503 X_1 + 5.38 X_2 + 0.03 X_1^2 - 6.39 X_2^2 + 1.5 X_1 X_2$$

Projectile weaving machine:

$$Y(\text{Ne } 50/1) = 79.75 + 6.3 X_1 + 5.69 X_2 - 0.218 X_1^2 - 1.065 X_2^2 + 1.19 X_1 X_2$$

$$Y(\text{Ne } 80/1) = 61.5 + 0.81 X_1 + 8.43 X_2 + 0.275 X_1^2 - 8.765 X_2^2 + 1.122 X_1 X_2$$

Air jet weaving machine:

$$Y(\text{Ne } 50/1) = 63.47 + 19.81 X_1 + 3.36 X_2 + 3.01 X_1^2 + 1.465 X_2^2 + 2.425 X_1 X_2$$

$$Y(\text{Ne } 80/1) = 43.55 + 10.16 X_1 + 0.983 X_2 - 1.483 X_1^2 - 2.23 X_2^2 + 1.16 X_1 X_2$$

By using these equations the response surfaces and contour surfaces for weft tension as a function from weft insertion rate and modulus of elasticity of weft threads could be plotted as shown later.

4- Experimental results

- Fig 2 shows a typical signal of weft tension during picking on rapier-, projectile- and air jet weaving machine.
- Figs. 3,4,5 and 6 shows the surface plot and contour plot for weft tension as a function from weft insertion rate and modulus of elasticity of weft thread during picking a cotton weft yarns Ne 50/1 and Ne 80/1 on rapier weaving machine.
- Figs. 7,8,9 and 10 shows the surface plot and contour plot for weft tension as a function from weft insertion rate and modulus of elasticity of weft thread during picking a cotton weft yarns Ne 50/1 and Ne 80/1 on projectile weaving machine.
- Figs. 11,12,13 and 14 shows the surface plot and contour plot for weft tension as a function from weft insertion rate and modulus of elasticity of weft thread during picking a cotton weft yarns Ne 50/1 and Ne 80/1 on air jet weaving machine.

DISCUSSION AND CONCLUSION

Fig. 2-a shows a typical shape of the signal of weft tension during one picking cycle on rapier weaving machine, in general the weft tension shape is a function from the speed shape of picking element (sine curve for a double rapier). The sudden increase in the left half side of the signal is due to accelerating the weft thread during movement of the taker rapier.

Fig. 2-b shows a typical shape of weft tension during one picking cycle on projectile weaving machine, at first due to accelerating the weft thread to a maximum withdrawing speed the weft tension has a sudden increase. Then the weft tension has a steady value during the continuous unwinding from yarn storage. Due to weft braking at the end of picking cycle a slight increase in the weft tension took place.

Fig. 2-c shows the shape of weft tension during one picking cycle on air jet weaving machine, during withdrawing the weft thread by means of the air through the shed a slight increase in weft tension occurred. The weft tension has a sudden increase due to stopping the weft thread after its arriving to the other side of the weaving machine, after that due to beating up process the weft tension has a small increase in its value.

At a constant weft insertion rate the pneumatic weft insertion system has a low value of weft stresses than the mechanical weft insertion systems, Table 1 shows the ratio between weft stress and weft tenacity by picking on the different types of weaving machines. The weft stress increases with decreasing the longitudinal density of weft thread.

Table 1

	Ratio between weft stress and weft tenacity		
	rapier up to 1000 m/min	projectile up to 1300 m/min	air jet up to 1700 m/min
weft thread (Ne 50/1)	22 %	34 %	36 %
weft thread (Ne 80/1)	24 %	44 %	37 %

As shown in Fig. 3 and 4 during picking on rapier weaving machine the modulus of elasticity of weft thread Ne 50/1 has the main effect on the variation in weft tension, the value of weft tension increases with increasing the modulus of elasticity. But the increase in weft insertion rate has a negligible effect on the weft tension, this is due to the variation in dynamic movement of weft yarn brake (spring plate type) with the increase of weft withdrawal speed /11/.

Figs. 5 and 6 shows that the variation in weft insertion rate has a small effect on the value of weft tension, and in some conditions (at a high weft withdrawal speed) the value of weft tension decreases with increasing the value of weft insertion rate, this is due to the variation in the vibrating frequency of the used weft brake (spring plate type) with the increase in the value of weft withdrawal speed /11/. The modulus of elasticity of weft thread has the main effect on the variation of weft tension, the value of weft tension increases with increasing the modulus of elasticity of weft thread.

By picking the weft thread Ne (80/1) on the rapier weaving machine the value of weft tension decreases slightly with increasing the weft insertion rate, this is due to the same mentioned reasons by picking weft threads Ne (50/1). But the modulus of elasticity of weft thread has the main effect on the variation of weft tension, the value of weft tension increases with increasing the modulus of elasticity of weft thread, see Figs.5 and 6.

As shown in Figs. 7 and 8 by picking weft thread Ne (50/1) on projectile weaving machine both weft insertion rate and modulus of elasticity of weft thread have a significant effect on the variation in weft tension, the value of weft tension increases with increasing both weft insertion rate and modulus of elasticity.

Figs. 9 and 10 shows the variation in weft tension during picking weft threads Ne (80/1) on projectile weaving machine, it was found that the value of weft tension decreases slightly with increasing the weft insertion rate, the reason of this behaviour was described in /11/. The modulus of elasticity of weft thread has the main effect on the variation in weft tension, the value of weft tension increases with increasing the modulus of elasticity of weft thread.

Figs.11,12,13 and 14 shows the behaviour of weft tension during picking of cotton weft threads (Ne 50/1 and 80/1) on air jet weaving machine, it was found that the weft insertion rate and modulus of elasticity of weft thread affect the variation of weft tension. The value of weft tension increases with increasing weft insertion rate and modulus of elasticity of weft thread, the weft insertion rate has the main effect on the variation of weft tension.

To reduce the value of weft tension during picking on the mechanical weft insertion systems (rapier and projectile) a weft threads with a low value of modulus of elasticity should be used.

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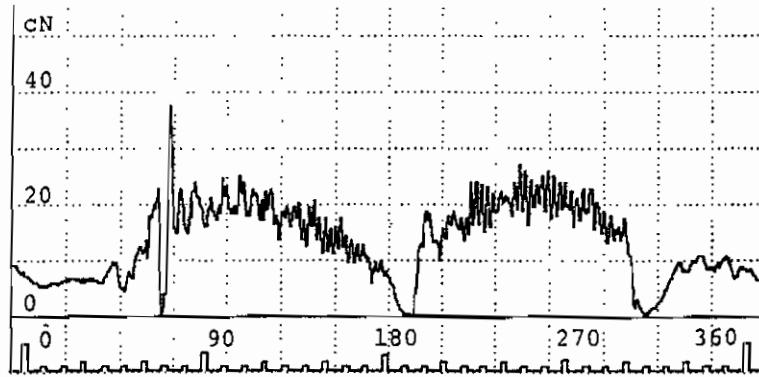


Fig.2-a Typical signal of weft tension during picking on rapier weaving machine

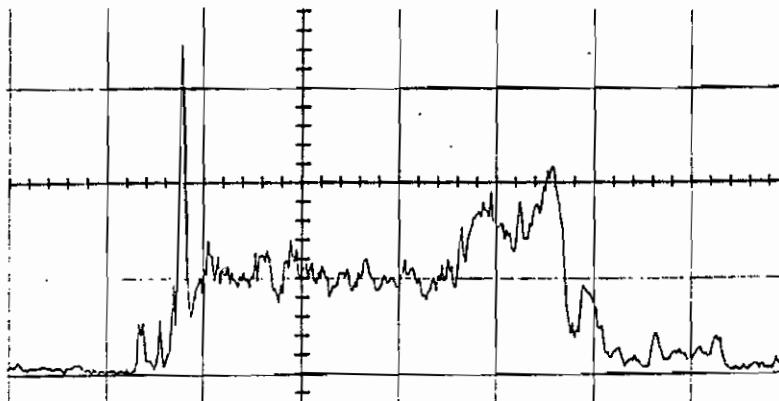


Fig.2-b Typical signal of weft tension during picking on projectile weaving machine

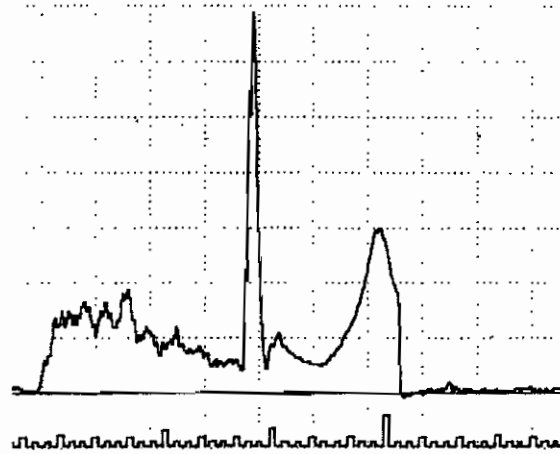


Fig.2-c Typical signal of weft tension during picking on air jet weaving machine

Rapier weaving machine
cotton weft thread Ne 50/1

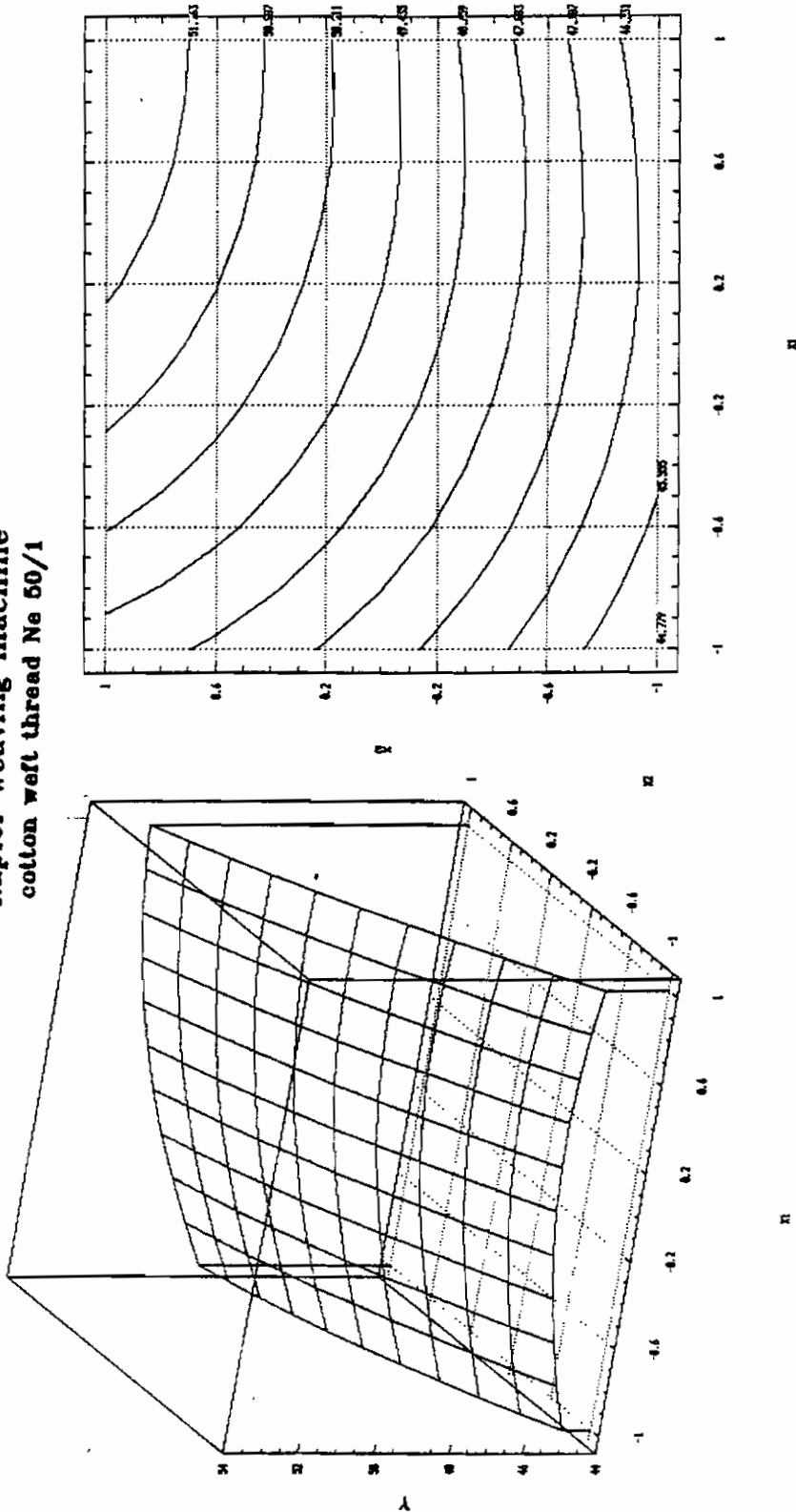


Fig.3 Weft insertion rate X_1 and weft modulus X_2 versus weft tension Y

Fig.4 Contours of weft tension at the levels of weft insertion rate X_1 and weft modulus X_2

**Rapier weaving machine
cotton weft thread Ne 80/1**

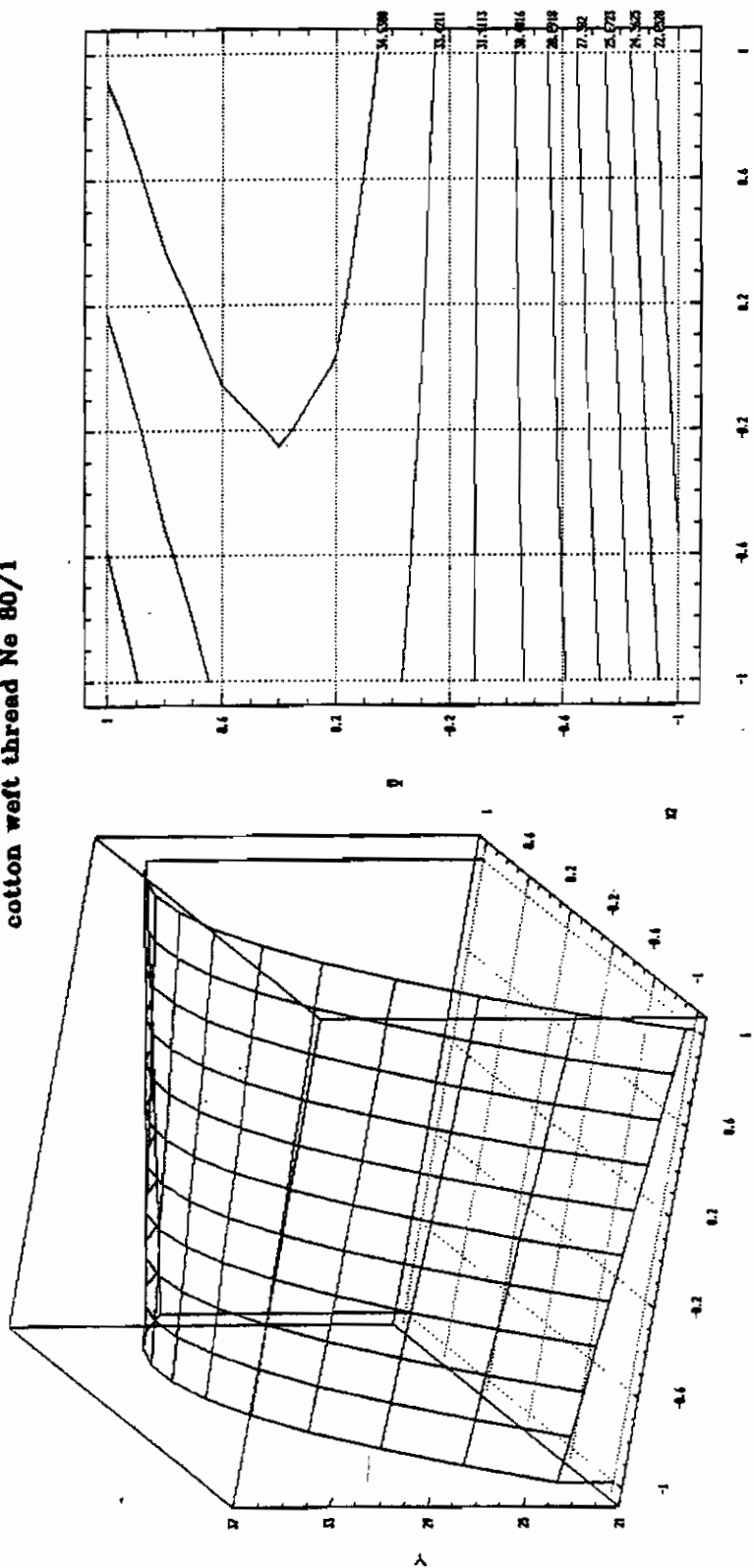


Fig. 5 Weft insertion rate X1 and weft modulus X2 versus weft tension Y.

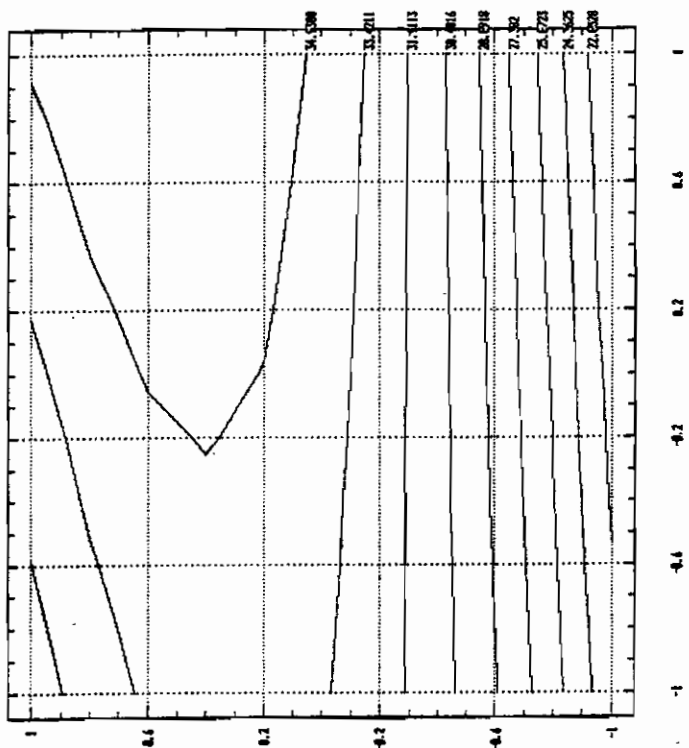


Fig. 6 Contours of weft tension at the levels of weft insertion rate X1 and weft modulus X2

**Projectile weaving machine
cotton weft thread Ne 50/1**

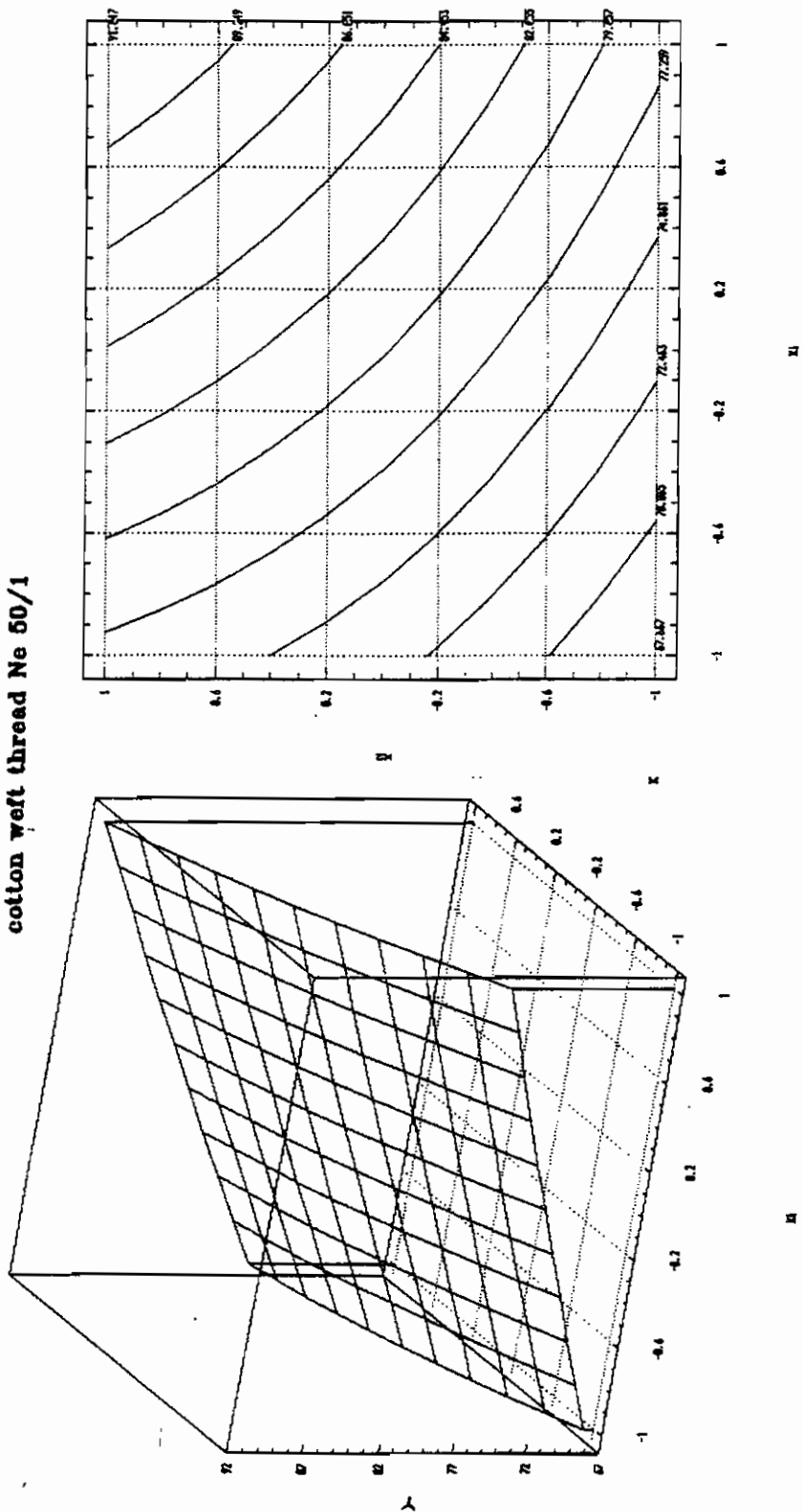


Fig. 8 Contours of weft tension at the levels of weft insertion rate X1 and weft modulus X2

Fig.7 Weft insertion rate X1 and weft modulus X2 versus weft tension Y

Projectile weaving machine
cotton weft thread Ne 80/1

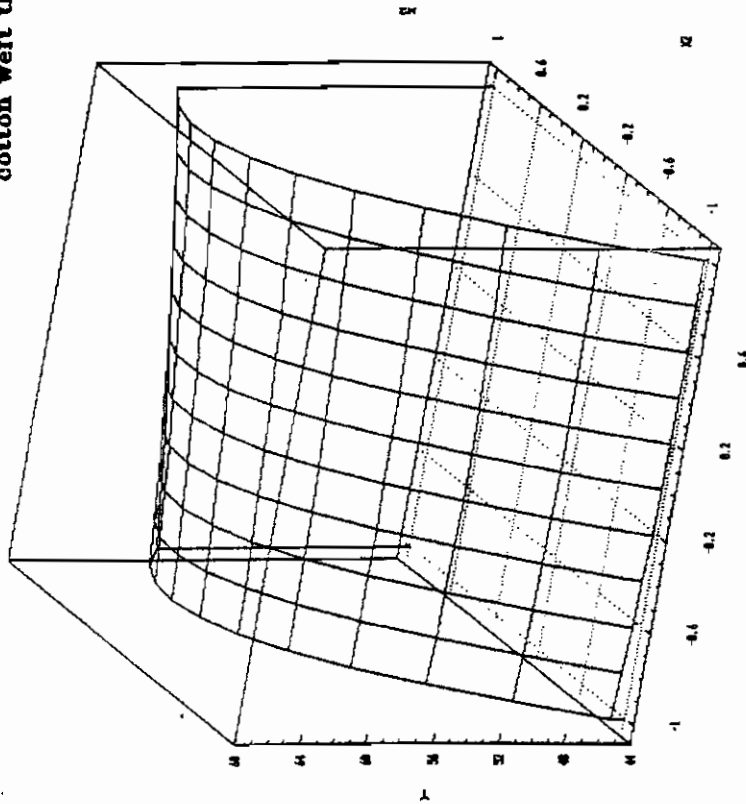


Fig.9 Weft insertion rate X1 and weft modulus X2 versus weft tension Y

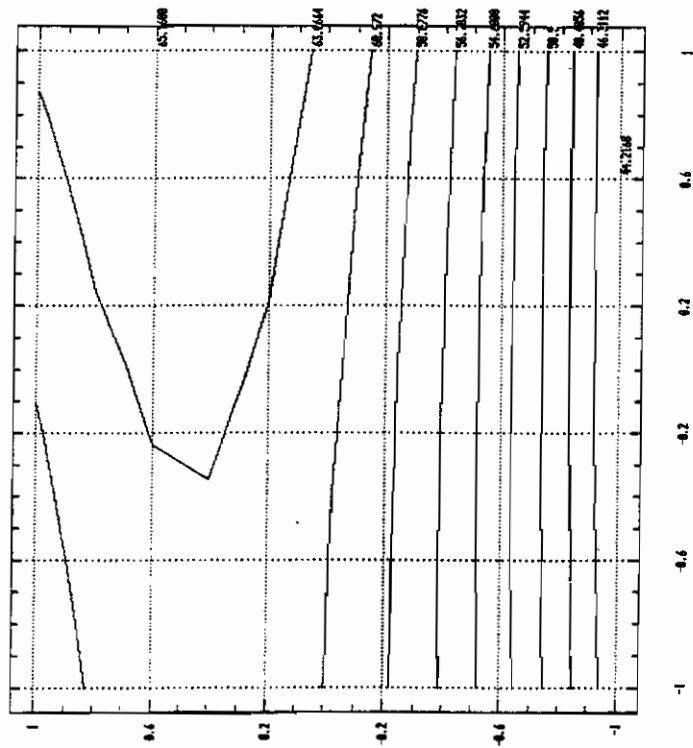


Fig. 10 Contours of weft tension at the levels of weft insertion rate X1 and weft modulus X2

Air jet weaving machine
cotton weft thread No 50/1

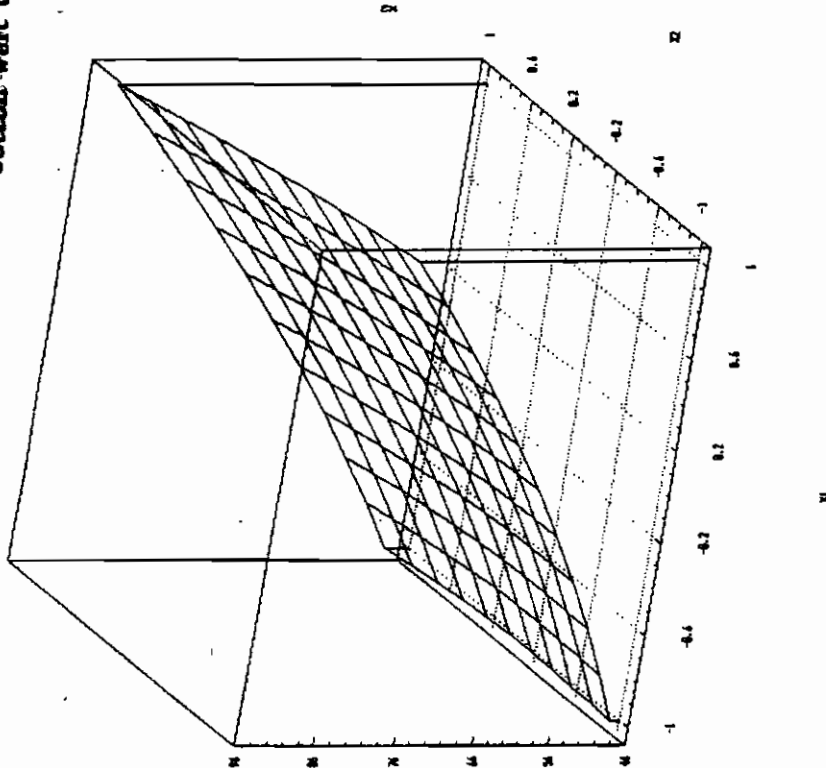


Fig.11 Weft insertion rate X1 and weft modulus X2 versus weft tension Y

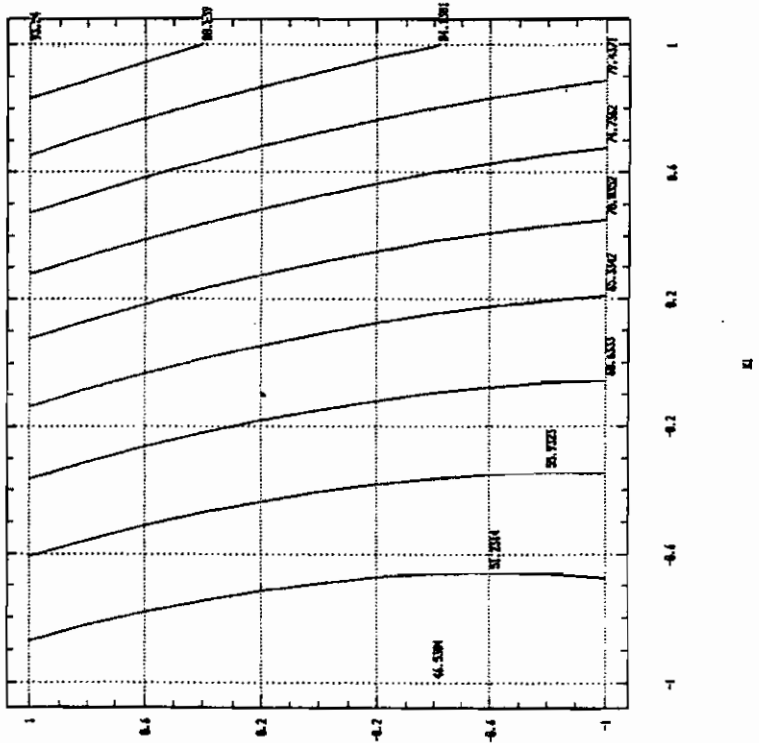


Fig. 12 Contours of weft tension at the levels of weft insertion rate X1 and weft modulus X2

**Air jet weaving machine
cotton weft thread Ne 80/1**

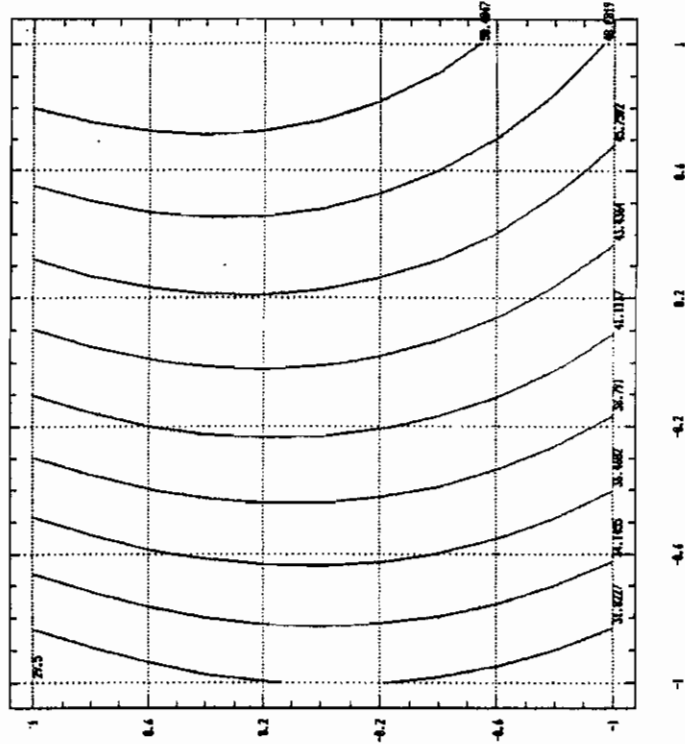
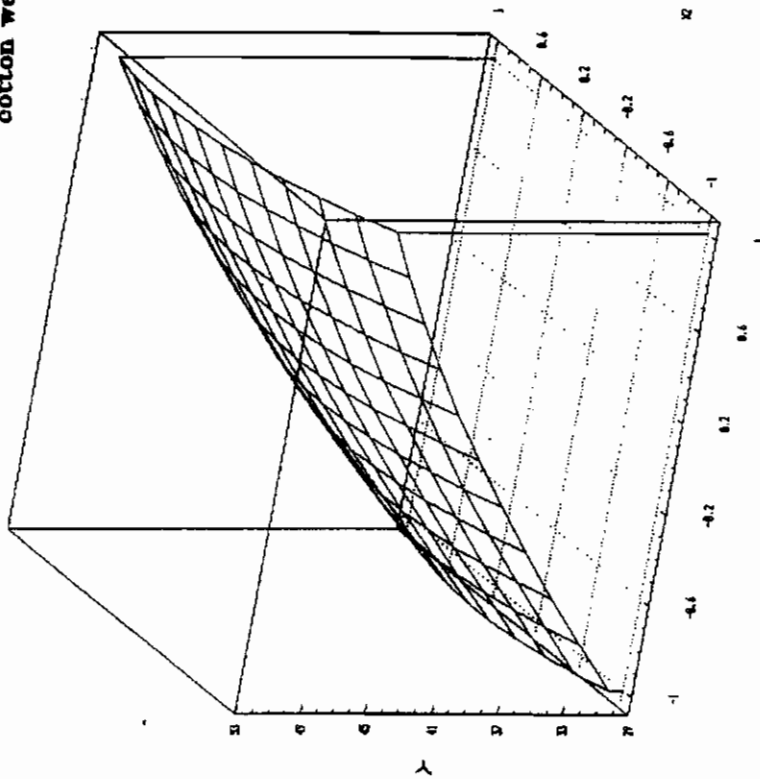


Fig. 14 Contours of weft tension at the levels of weft insertion rate X1 and weft modulus X2

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