WARP TENSION DISTRIBUTION ACROSS WARP SHEET ON AIR JET WEAVING MACHINE

by
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"توزيع أجهاد خيوط السداء على عرض ماكينة النسيج ذات قذف هوائى"

الخلاصة

فى هذا البحث تم تحديد توزيع الشد عمليا على أحد ماكينات النسيج ذات القذف الهوائى
ياس الشد الاقصى الديناميكى الناتج من تكوين فتحة النفس وأزاحة المشط لخيوط اللحمة خلال
ورتين متتاليتين لنسيج سادة ١/١ بالاضافة الى قياس الشد الاستاتيكى عند تساوى الممتاز
الهندسى لخيوط السداء وذلك فى ٣٠ موضعا موزعة على عرض ماكينة النسيج مع تغيير السرعة
ن ٤٥٠ الى ٥٠٣ لفة فى الدقيقة وكذلك مع تغيير ضغط المساند الهوائية الخلفية التى ترتكز
يها ماكينة النسيج . كما تم قياس التباين فى شد خيوط السداء المتتالية من خيط لاخر
من درأ الى آخر فى ٦٠ موضعا موزعة على ستة مجموعات . وقد أظهرت النتائج أن توزيع
لاجهادات الديناميكية لخيوط السداء على عرض ماكينة النسيج تتبع شكل محدد تابع لتوزيع
لاجهادات الاستاتيكية لتلك الخيوط . كما أن التباين فى قيمة الشد لخيوط السداء المتجاورة
نفس الدرأ فى معظم الحالات يكون معنويا .

ABSTRACT

In this work experimental measurments were carried-out Sulzer-Ruti L5000 air jet weaving machine under two differe- weaving machine speeds and two different air pressure of the re machine supports. The experiments also included the effect heald shaft position and warp thread position within the sa heald shaft on the values of warp tension.

The maximum dynamic tension of single warp threads caused beat-up and shedding were measured in addition to their bas. static tension for two successive weaving machine cycles duri weaving 1/1 simple plain weave at 30 differant positions regular. spaced across warp sheet width in the same heald shaft and dropp. bar.

The previous warp tension values for the first and the la. heald shaft on ten successive warp threads choosed from lef middle and right across the warp sheet width were also measured determine the tension variation within and inbetween heald shafts.

INTRODUCTION

One of the main requirements of weaving is the use of temples to overcome the lateral cloth tension which arises from the weft crimp at the cloth fell due to warp interlacing, which tends to reduce cloth fall width than that in reed and hence, exposing the warp thread at both cloth sides to severe abrasion and finally inurmus end breaks.

Therefore temples could affect the lateral distribution of warp tension i.e. across warp width due to the interchange relation between warp and weft crimps and consequantly tensions specially at cloth fell where the first woven cells are formed.

One of the early experimental attempets to study this effect was carried out by measuring some indirect effects of the uneven distribution of warp tension across warp sheet /1/ such as degree of bowed wefts and differences of warp crimp values at selvdege, cloth sides and middle of cloth, this study showed an actual differences without direct measurement of tension values during weaving.

The direct dynamic measurements /2/ of such values were tried on shuttle and rapier weaving machines at twenty five positions distributed across warp sheet showed again a real variation within temple zones and at selvedge and even tension across warp sheet without giving an explaination for such distribution or the epecific way of measuring tension values, these measurments included only the maximum shedding tension for both weaving machines without measuring maximum values due to beat-up at upper and lower shedding cycles.

With the rapid increase of non-conventional weaving machine speeds, the studies /4/,/5/ and /7/ assured that increase of weaving machine speed has very little noticeable effect on warp tension and on the contrary has a great effect on weft tension values.

The warp tension also was found to varied from one heald shaft to another specially when a larg number of heald shafts are used to produce certain fabric structures while maintaining clear shad.

The warp thread vibration was found /4/ to be affected mainly by the back rail oscillation and reed beat-up movement while the weaving machine vibration was found /8/ to be weakly affected by the warp static tension values.

Neither The warp tension distribution from previous studies across warp sheet was not yet clearly found to be studied experimentally specially on unconventional weaving machines nor temple effects was specifically determined.

In this paper precise and comprehensive measurments of warp tension values across warp sheet width was carried out to determine the shape of this distribution and the effect of both temples on it through measuring five tension values of two successive weaving machine cycles of maximum tension due to shedding and beating-up in addition to static value of closed shed on air jet weaving machine. Also a new study of warp tension distribution through successive warp threads within the same heald shaft and inbetween heald shafts was attempted.

Finally the springness effect of the pneumatic rear weaving machine supports on warp tension distribution was also studied. These three studies are considered to be of great. industrial importance in determining the zones of maximum value of warp tension across weaving machine width so that it could be checked up to assure high weaving efficiency.

EXPERIMENTAL

1- Specification of weaving machine and material used

Type of weaving machine	Sulzer-Ruti L5000 (air jet)
Weaving machine speed	up to 503 picks/min
Maximum reed space	190 cm
Warp width in reed	175 cm
Pressure of rear pneumatic m/c support ...	2.7 and 3.5 bar
Ends/cm	19, 2x16.5 tex cotton/polyester
Picks/cm	26, 2x16.5 tex cotton/polyester
Number of heald shafts....................	4
Fabric structure	plain weave

The weaving machine is equiped with automaticall positioning of back rail at weaving stops to deminish setting-on marks

2- Instrumentation of warp tension measurments

The RES three support system of tension measurment waa used by intiating resistant strain gauges electronically connected to a measuring circut of 31 KHZ,the signal is then fed to an amplifier of 500 KNZ (GSP 114) and finally demonstrated by a cathod ray oscilliscope with a recording facilities the signal could be later plotted graphically with the suitable speed using a chart recorder.

3- Experimental procedure

- twenty one single warp threads distributed across the warp sheet width were marked provided that they pass through the first heald shaft and the last dropper bar, also ten successive warp thread were choosen in the left hand side, middle and the right hend side of the first and last heald shaft at a distance 0.5 cm from selvedge.
- the measuring head of the (RES) were introduced through the epecified warp threads in the region between the oscillating back rail and the last dropper bar to record their tensions consequantly.
- the recorded tension cycles were obtained by running the weaving machine first until stable weaving condition was reached by observing the consistancy of the shape and values of the recorded cycles then twenty successive signals will be

recorded and stored in the cathod ray oscillıscope with recording fascilities,these twenty signal will then be transfered into chart recorded at appropriate speed,the weaving machine then brought to stop with the heald shaft level and the static warp tension then could be recorded at the end of the twenty cyclee.

4- Evaluation of experimental results

- Fig 3 and 4 shows a typical recorded signals of warp tension for seven successive weaving machine cycles with their static tension value where the shedding tension values could be evaluated through approriate calibration noting that maximum shedding tension have two distinctive values (2) and (4) ulternated through weaving machine cycles due to the imbalance of the shed geometry where (2) represents the maximum shedding tension of the lower heald shaft and (4) represent the maximum shedding tension of the upper heald shaft i.e. the back rall is lifted over its netural position. The same applies an beat-up tension as shown in point 1,3 and line 5 represent the static tension value.

- The average value of ten readinga for each of the four mentiond parameters could be then obtained for the same warp thread,the eame procedure could be then repeated for the twenty-one marked warp thread to form the distribution across the warp sheet width as shown in Fig 5,6 and 7 in addition to the single value of static tension. The same procedura could be repsated for the sixty warp threads choosen as previously described to show the variation inbetween threade and inbetween healds as shown in Fig 8-13.

5- Experimental results

- Fig 5 , 6 shows the warp tension values due to static closed shed,beat-up at lower shed,beat-up at upper shed,maximum lower shed and maximum upper shed plotted against warp sheet width at weaving machine speed of 450 and 503 picks/min. Fig 7 shows the same five warp tension values plotted against the same locations of warp threads across the warp sheet width where the air pressure of the two rear pneumatic weaving machine supports is lowered by 30 % from the normal value i.e. 2.1 bar for the left side and 2.6 bar for the right drive side.

- Fig 8-13 shows the previously described five tension values plotted against ten successive warp threads which are selected from the following locations, first heald shaft left),last heald shaft (left), first heald shaft (middle), last heald shaft (middle), first heald shaft (right), last heald shaft (right) respectivly. Table 1 shows the statistical certianty test at 95 % confidence limit for the maximum dynamic values of the warp tension for the sixty warp threads choosen from the first and last heald shaft.

DISCUSSION

It is obvious that the general distribution of the four dynamic warp tension values across warp sheet as shown in Fig 5,6 and 7 follows exactly their static tension distribution with an increase reachs 200 % from their static values. It is also obvious that the fifteen plotted curve follow one distinctive convex shape of distribution which shows a noticeable increase at tht middle with low decrease at both sides specially at the weft insertion side. While the temple zones shows a sharp increase of tension values followed by a sharp decrease just after the end of temples from that general convex distribution.

By considering equal tension values for the warp threads within the fabric at the take-up roller, and that their is a degree of inclination between the woven warp threads and the free warp threads at the cloth fell, the vertical component will decrease with the increase of this inclination angle. The temples are mainly used to diminish this degree of inclination to make the weaving possible but it only affects a small strip of the fabric which can not prevent totally the uneven warp tension from reaching the free warp threads which is ready to be woven, such behaviour could explain this general distribution.

The use of temples also affects the straightness of weft threads speoailly just after paseing them due to the cloth overlap over temple rollers - which does not extend over the whole cloth width - and hence the weft takes alawys a bowed shape and lose its perpendicular direction on warp threads specially at the end of temples. The inclination of weft threads from their horizontal final direction which is visually noticeable may lead to side sliding of warp threads at temple ends towords the fabric centre which may lead in turn to an increase of ends density in the nearest fabric strip at the temple ends and consequently a low ends density in the neighboring strip of fabric inside temples, this process is intiated by both weaving machine vibration and low values of yarn to yarn coefficient of friction .

This local variation of ends density around the temple ends will affect the crimp interchange relation with weft thread and the tension distribution at this zone , Fig 5,6 and 7 shows a sharp increase with low warp density and visevers, the high warp density may cause high weft crimp which will lead in turn to low warp crimp and hence low warp tension and visevrse.

The distribution of the maximum warp tension values due to the beat-up at upper and lower sheds seems to have asymmetry shape while the other two tension values in addition to the static values seem to have a good symmertical shape, this could be explained by more effective beat-up action at the right drive side due to mechanical deformation of beat-up elements.

The increase of weaving machine speed from 450 to 503 p.p.m Fig 5 and 6 showed no effect on both tension values and tension distribution across warp sheet, while decreasing the air pressure of the rear pneumatic weaving machine supports by 30 % has showed an increase in both maximum values caused by beat-up at lower shed and maximum values caused by shedding in either lower and upper shed.

Inspite of the equality of the geometrical path of all warp threads passing through all heald shafts during static measurement of warp tension, the experimental results show clearly that static warp tension of the last heald shaft is always less than the first one by about 50 %, which means that the warp threads passing through the last heald shaft have been exposed to some degree of plastic deformation more than those threads passing through the first heald shaft, a matter which could not be avoided to obtain clear shed specially in air jet weaving machine, this means that a change in fabric properties from yarn to yarn is also expected although normal fabric' testing could not estimate such short term variation, unless the number of heald shafts is great.

Another noticeable remark from Fig 8-13 is that the four dynamic tension values are more dispersed in the last heald shaft than the first one. This may be due to lower value of static tension of the last heald shaft than the first one /9/, it is also noticed that the average value of dynamic closed shed tension is always less than the static one as shown in Fig 3 and 4 specially for the last heald shaft.

As shown in Table 1 The variation in warp tension values for the single successive warp threads (under the same conditions) are significant ,which could be related to the individual variation of yarn properties from yarn to yarn during spinning process with respect to linear density and twist distribution which affect the uniformity of their elastic modulus and as the weaving machine imposes only a uniform extension the developed tension may not be the same , an additional reasons could be due to variation of tension applied during winding and warping or the variation of the picked-up sizing %. A more obvious reason could be due to warp crossing in the region between the warp beam and the first lease rod or due to the entanglement of the warp threads in the region between the last dropper bar and the cloth fell.

CONCLUSION

- The improvement of warp tension uniformity across warp sheet is considered to be of great industrial importance to aviod excessive warp stress during weaving and to produce a fabric of homogeneous quality across its width.

- The pressure values of the rear pneumatic weaving machine supports must be adjusted with a suitable air pressure values to aviode the increase in warp stresses due to the vibration of weaving machine elements during weaving process..

- the warp tension distribution across the warp sheet shows alawys a convex shape of high stresses at the middle and some asymmetry from one side to the other, the reason is mainly due to the degree of inclination between the woven warp threads and the free warp threads.

- The use of temples could act to reduce such effect although they are the main reason in bowing the weft threads and disturbing the warp tension distribution specially at the temple tips.

- The measurements of static warp tension distribution can give a very good estimate of the expected shape although is far less than the real dynamic values by 50 %.

- The dynamic warp tension is expected to exceeds the elastic limit of the woven warp threads specially by weaving at high static warp tension level on modern weaving machine with a high number of heald shafts .

- The increase of weaving machine speed within 10 % does not have a significant effect on warp tension values or distribution while the weaving machine fixation with pneumatic support has some effect only on the tension values.

- It is very recommended to extend the straight part of the woven cloth which begins from cloth fell and keeps the straightness between the woven warp threads and the free warp threads to improve the uniformity of warp tension across warp sheet, this could be actually realized by using multi-successive temples at both cloth sides.

- It is also preferd to reduce the length of overlaped cloth over the temple rollers to improve weft thread straightness and the warp tension distribution, this could be realized by using temples with smaller diameter and longer lengthes better than large diameter and short length.For other reasons it can not decrease the wraping cloth angle around temple surface and temple diameter under certain limits because the cloth must be stretched with a definite force to perform the weaving process.

- As it is necessery to obtain clear shed epecially with air jet weaving machine,exccessive warp stresses on the rear heald shafts is inevitable and it is prefered either to reduce the number of heald shafts or to reduce the thickness of healds for the sake of improving fabric quality and end breaks.

- The indvidual variations of tension values inbetween warp threads having the same conditions is also inevitable and it is recommended to improve yarn quality, winding, warping and sizing percent to reduce these variations. In addition avoiding werp thread crossing during drawing-in and entalgelement during weaving process can improve such individual variations.

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Typical recorded signals of warp tension
first and last heald shaft

1-beating-up (lower shed) 2-maximum lower shed
2-beating-up (upper shed) 4-maximum upper shed
5-static warp tension

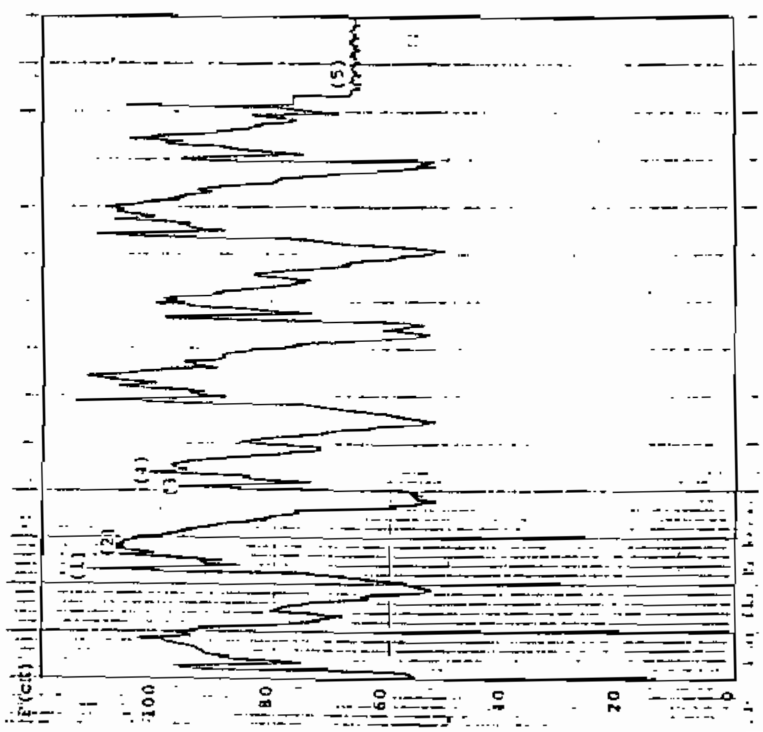


Fig. 3

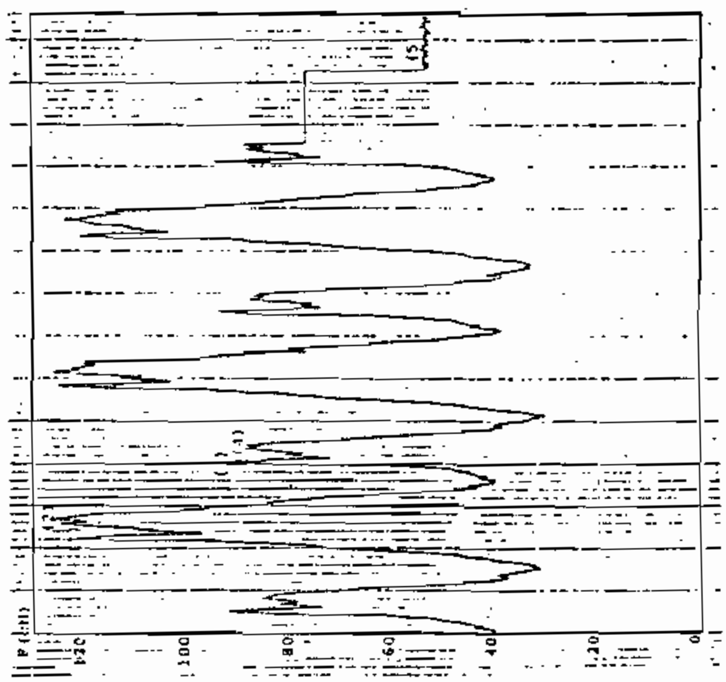
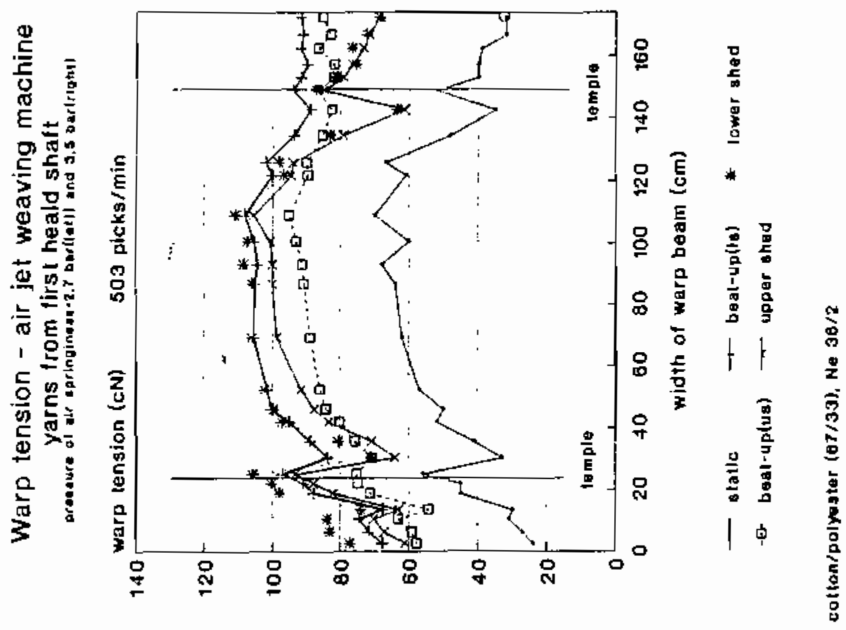
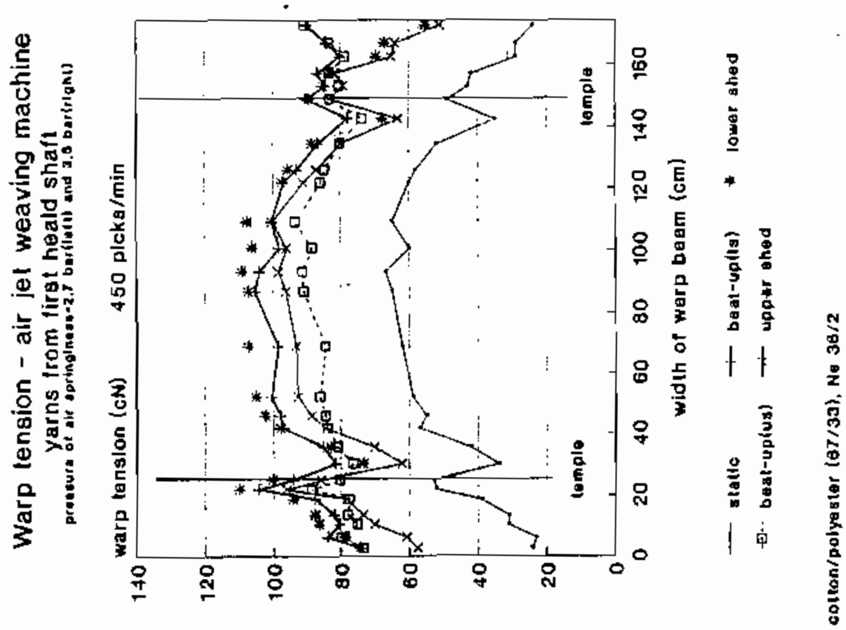


Fig. 4



Warp tension - air jet weaving machine
yarns from first heald shaft
pressure of air springiness-2.7 bar(left) and 3.5 bar(right)
warp tension (cN)
503 picks/min
temple
temple
width of warp beam (cm)
static
beat-up(ls)
lower shed
beat-up(us)
upper shed
cotton/polyester (67/33), Ne 36/2

Fig. 6



Warp tension - air jet weaving machine
yarns from first heald shaft
pressure of air springiness-2.7 bar(left) and 3.5 bar(right)
warp tension (cN)
450 picks/min
temple
temple
width of warp beam (cm)
static
beat-up(ls)
lower shed
beat-up(us)
upper shed
cotton/polyester (67/33), Ne 36/2

Fig. 5

Table 1

group position			yarn position 1	2	3	4	5	6	7	8	9	10
first heald shaft	left	tension,cN	97	100	114	97	100	108	93	103	97	104
		confidence interval,cN	1.5	1.9	1.2	1.2	2.7	1.8	2.4	1.9	1.6	1.7
	middle	tension,cN	136	137	142	133	129	136	135	133	137	123
		confidence interval,cN	1.7	0.8	2	1.7	1.8	2.1	1.5	1.7	1.7	2.3
	right	tension,cN	113	108	104	118	121	113	115	105	113	117
		confidence interval,cN	3.3	2.4	2.3	5.4	2.2	2.2	3.1	2.4	4.5	3.3
last heald shaft	left	tension,cN	125	116	121	98	122	99	98	90	87	100
		confidence interval,cN	2	1.1	2.5	2.7	2.8	1.9	0.7	2.3	0.7	2.7
	middle	tension,cN	130	134	144	132	131	136	139	136	140	128
		confidence interval,c	1.7	2.8	1.9	1.6	2.4	1.3	2.3	2.2	1.2	1
	right	tension,cN	96	101	104	93	105	102	95	109	103	108
		confidence interval,cN	3.2	2.6	4	2.6	2.5	2	2.5	1.6	1.5	4.2

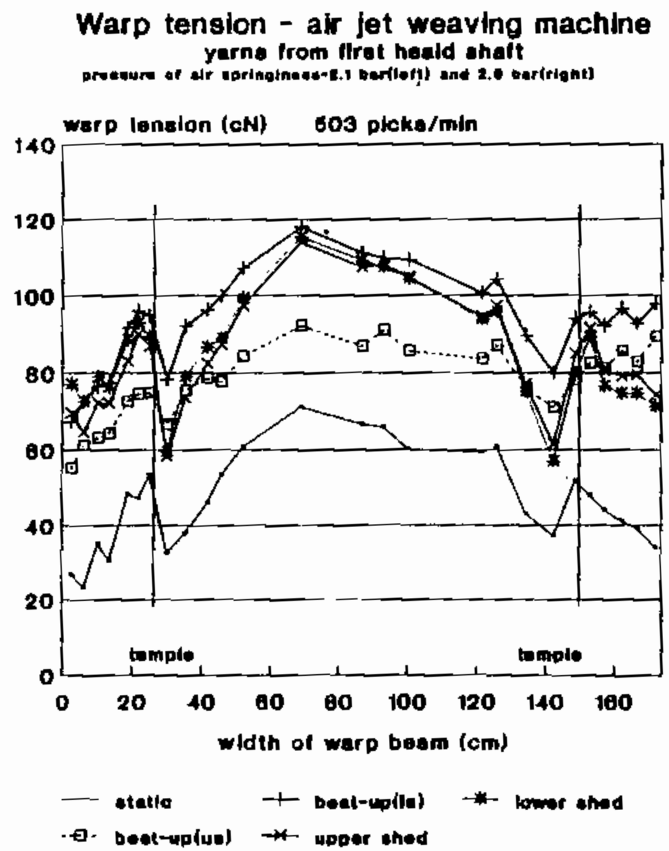


Fig.7

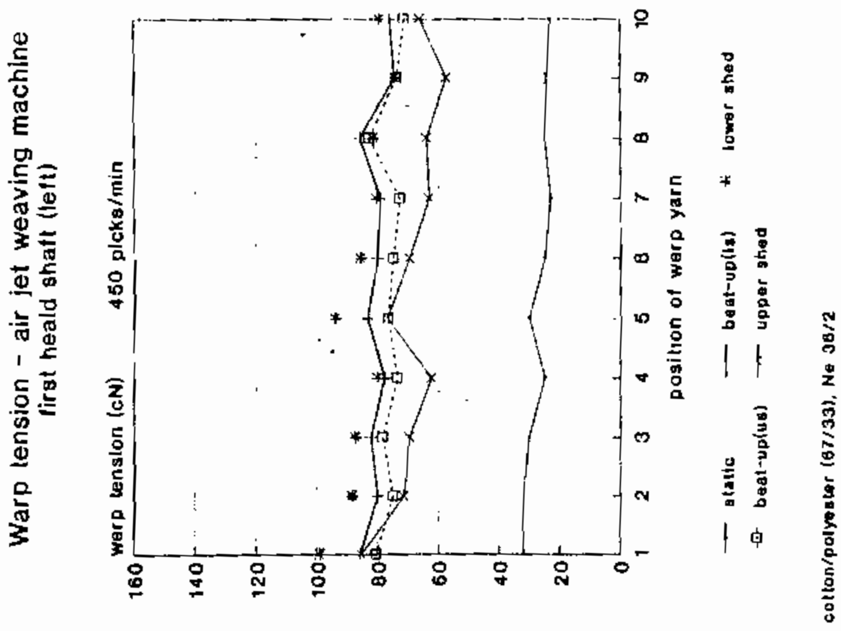

Warp tension - air jet weaving machine
first heald shaft (left)
warp tension (cN)
450 picks/min
160
140
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
position of warp yarn
static
beat-up(ls)
lower shed
beat-up(us)
upper shed
cotton/polyester (67/33), Ne 36/2

Fig. 8

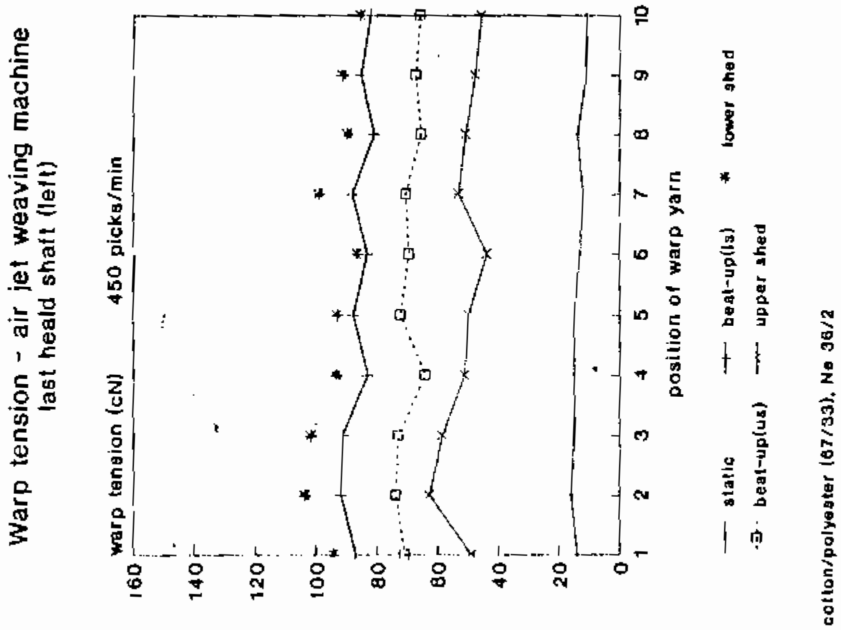

Warp tension - air jet weaving machine
last heald shaft (left)
warp tension (cN)
450 picks/min
160
140
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
position of warp yarn
static
beat-up(ls)
lower shed
beat-up(us)
upper shed
cotton/polyester (67/33), Ne 36/2

Fig. 9

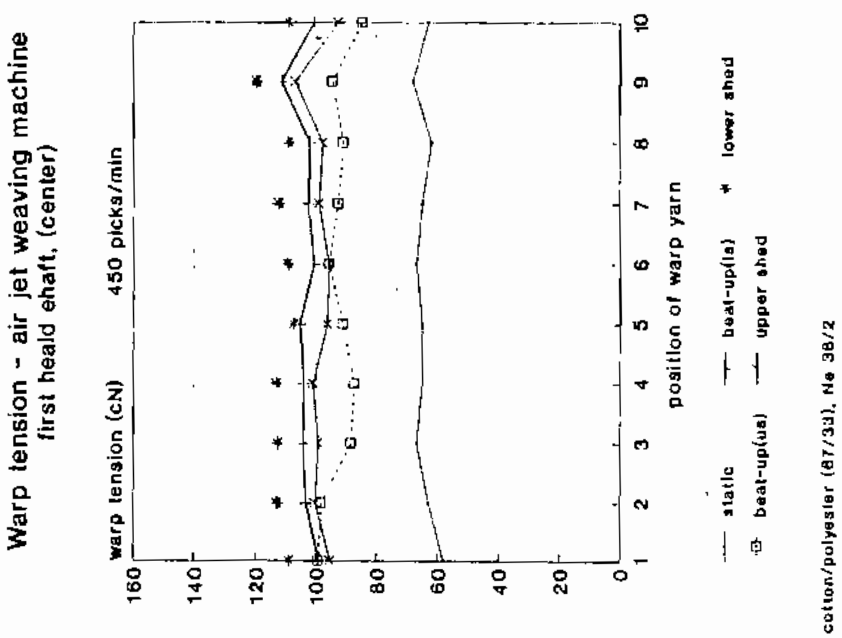

Warp tension - air jet weaving machine
first heald shaft, (center)
warp tension (cN)
450 picks/min
position of warp yarn
static
beat-up(ls)
lower shed
beat-up(us)
upper shed
cotton/polyester (67/33), Ne 38/2

Fig. 10

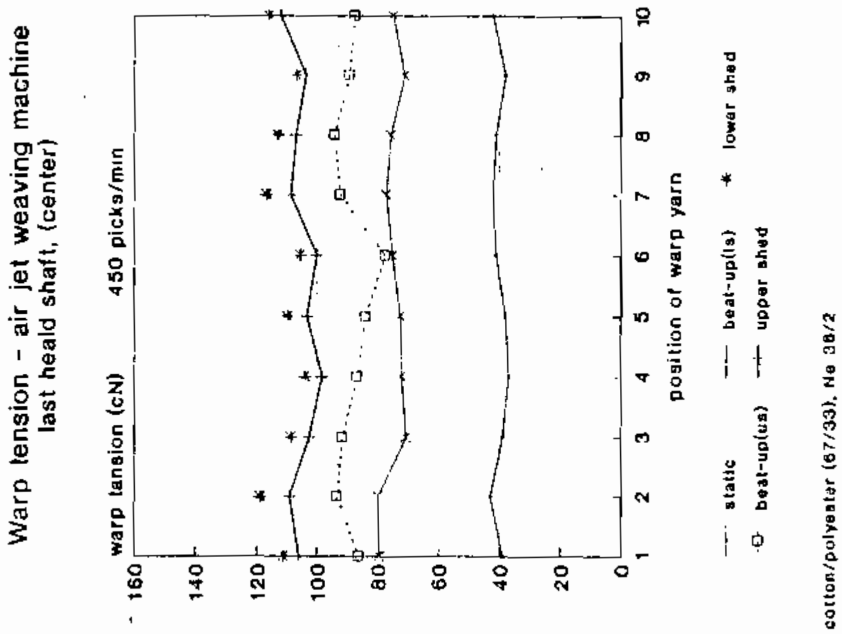

Warp tension - air jet weaving machine
last heald shaft, (center)
warp tension (cN)
450 picks/min
position of warp yarn
static
beat-up(ls)
lower shed
beat-up(us)
upper shed
cotton/polyester (67/33), Ne 38/2

Fig. 11

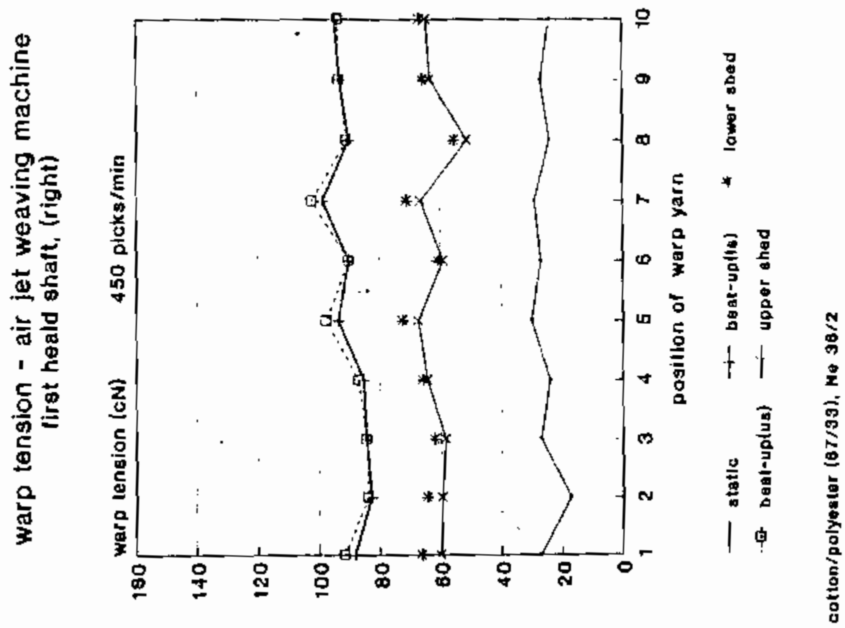

warp tension - air jet weaving machine
first heald shaft, (right)
warp tension (cN)
450 picks/min
0
20
40
60
80
100
120
140
160
1
2
3
4
5
6
7
8
9
10
position of warp yarn
static
beat-up(ls)
lower shed
beat-up(us)
upper shed
cotton/polyester (67/33), Ne 36/2

Fig. 12

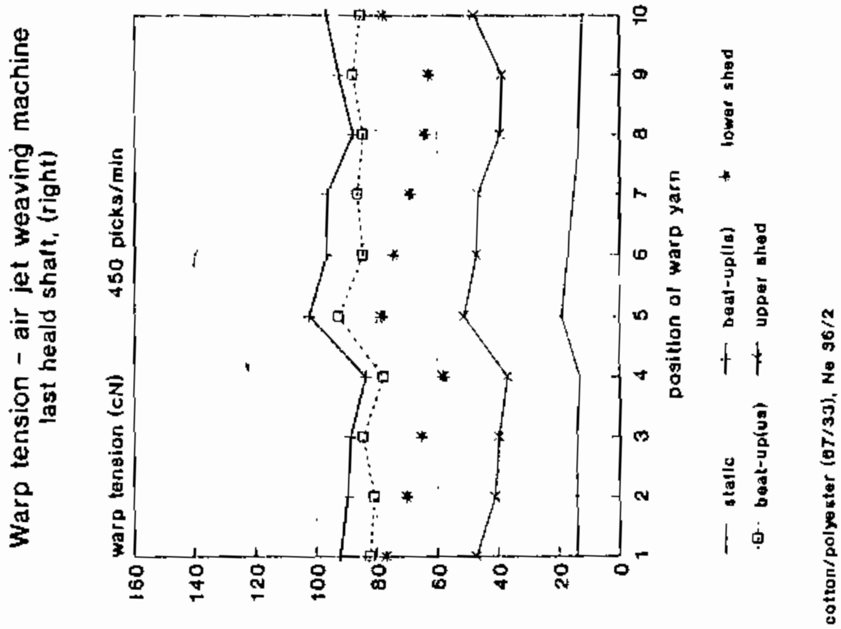

Warp tension - air jet weaving machine
last heald shaft, (right)
warp tension (cN)
450 picks/min
0
20
40
60
80
100
120
140
160
1
2
3
4
5
6
7
8
9
10
position of warp yarn
static
beat-up(ls)
lower shed
beat-up(us)
upper shed
cotton/polyester (67/33), Ne 36/2

Fig. 13