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Reduction of Weft Tensile Stresses during Picking on High Production Weaving Machines.

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REDUCTION OF WEFT TENSILE STRESSES DURING PICKING ON HIGH PRODUCTION WEAVING MACHINES

by
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تخفيض اجهادات شـــد خيوط اللحمه أثناء قذفها على ماكينات النسيج عاليه الانتاجيه

فى هذا البحث تم قياس تأثير كل من العوامل التاليه على اجهاد خيوط اللحمه أثناء قذفها على ماكينات النسيج المختلفه

- تجهيـز خيوط اللحمـه
- وضع الخيط علىبوبينة الغزل
- تغيـر زمن قذف الخيط
- تغير ضغط الهواء لوحدات القذف المساعده على ماكينه الهواء

وتم الوصول فى هذا البحث بأنه يمكن تخفيض اجهاد خيوط اللحمه أثناء قذفها على ماكينة الرابير حتى ٤٠٪ فى حاله تشميع الخيوط وحتى أكثـر من ٣٠٪ أثناء قذفها على ماكينة النسيج ذات المقذوف . أما بالنسبه للقذف على ماكينة النسيج ذات القذف الهوائى فلا يحدث أى انخفاض فى اجهادات شد خيوط اللحمه ولكن من جهه أخرى يمكن الهبوط بقيمة ضغط الهواء لوحدة القذف الرئيسيد بنسبة ١٢٪ حيث أن الماكينه يمكنها أن تنظم الضغط آليا . وقد وجد أن الخيوط المأخوذة من أعلىبوبينة الغزل تودى الى اجهاد أقل أثناء قذفها على ماكينات النسيج عن الخيوط المأخوذه من أسفل البوبينه . وكذلك يمكن تخفيض اجهادات خيوط اللحمه مع زيادة زمن القذف ونقصان ضغط وحدات القذف المساعده على ماكينة الهواء . بالاضافه الى ذلك تم حساب اجهادات الشد نظريا ومقارنتها بالقيم العمليه ووجد أنه يوجد توافق بدرجه عاليه بين الحسابات النظريه والعمليه .

ABSTRACT

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

- Air jet weaving machine L 5100 - 2m X 850 p.p.m.
- Projectile weaving machine P7100 - 4m X 350 p.p.m.
- Rapier weaving machine G 6100 - 2m X 450 p.p.m..

The values of weft tensile stresses were recorded under the effect of the following parameters:
- Surface characteristic of weft yarn.
- Position of yarn on spinning cops.
- Air pressure of multi-nozzels and duration of picking on air jet weaving machine.

It was found that the waxed weft yarns have a reduction in the tensile stresses of about 30 % and 40 % during picking on projectile- and rapier- weaving machine respectively. By picking on air jet weaving machine the waxed weft yarns have no influence on the reduction of weft tensile stresses but act to reduce the air pressure of the main nozzel by about 12 %.

The value of weft tensile stresses decreases with decreasing the air pressure of multi-nozzels and increasing the duration of picking on air jet weaving machine. The value of weft tensile stresses is low by picking the yarn from the upper layers in the cop and increases toward the yarn from the cop base.

INTRODUCTION

To increase the productivity of high production weaving machine the level of weft tensile stresses must be reduced. Many parameters affect the variation in weft tension, some of these parameters are common for different types of weaving machines, such as machine speed, and modulus of elasticity of weft thread.

It was found that /1/ the weft tensile stresses increase with increasing machine speed and decreasing modulus of elasticity of weft thread. Other parameters are related to the type of picking system.

In case of mechanical weft insertion systems, the characteristic of yarn surface is considered as one of the main parameters which affects the value of weft tensile stress. The weft stresses are function from linear density of weft yarn, acceleration of weft yarn during picking and smoothness of yarn surface /2/.

In case of air jet picking systems, the duration of picking is affected by many parameters such as type of winding, twist factor, yarn doubling, package diameter,etc..... Also it was found /3/that, yarn spun from short fibres has a high value of hairiness, this hairiness leads to a short duration of picking, but the singed weft yarns have a long duration of picking because the air drag force during picking is not sufficient to carry the weft to the other side in the same time. Due to the effect of spinning process the hairiness of yarn at the base of cop is higher than the top /9/. In case of filament yarns the duration of picking decreases with increasing the linear density of the yarn, but for cotton yarns the contrary occurs/4/.

Regarding the effect of weft package diameter on the duration of picking /5 and 6/, it was found that, the duration of picking for filament yarn decreases with decreasing package diameter while the opposite occurs with staple yarn. Also it was found that, packages with precision winding have a low duration of picking than package with drum winding.

Some adjustments of air jet weaving machine have an influence on weft stresses, by picking on weaving machines up to 600 p.p.m. the relation between pressure of multi-nozzels and maximum weft tension is linear and also the duration of picking increases with decreasing the pressure of main and multi-nozzels /7/.

The increase of speed of weaving maschine from 450 to 508 p.p.m. (about 13 %) leads to an increase in weft acceleration by about 17 % causing an increase in the speed of weft yarn of approximately 33 % /8/.

In the prsesnt work the effect of yarn finishing and yarn position in cop on the variation in weft tension during picking on rapier-, projectile- and air jet - weaving machines were measured. Also the effect of duration of picking and pressure of multi-nozzels on the maximum weft tension at machine speed (air jet) of 850 p.p.m. were measured.

EXPERIMEMTAL WORK

1- Specification of sulzer-Ruti weaving machines used.
   a) Air jet weaving machine L5100 (2m x 850 p.p.m.)
   b) Projectile weaving machine P7100 (4m x 350p.p.m.)
   c) Rapier weaving machine G6100 (2m x 450p.p.m.)
   and for all weaving machines mentioned above the following date are common during weaving a plain weave fabric :-
   - Picks/cm = 28 - Ends/cm = 47
2- Measurements and apparatus used
   Fig (1) shows the arrangement of the apparatus used. The weft yarn is withdrawn from package (1) through the yarn accumulator (2). A measuring head (3) was arranged directly before the picking element and the signal of weft tension was amplified through amplifier (4). The successive amplified signals could be accumulated in a memory for evaluation and recording process

The evaluation of the results in some of measurements is carried out by means of a micro-processor, where, the mean value of the peaks of weft tension could be calculated from 400 up to 1000 accumulated signals.

2.1 Measurements the effect of yarn position in cop on weft tension

For every weaving machine three cops (cotton Ne 50/1) were wounded seperatly in the form of packages and the value of weft tension was recorded firstly at the beginning of withdrawing from the package (yarn from cop base) and secondly at the end of withdrawing (yarn from cop top).The measured values of the peaks of weft tension were statistically analysed.

2.2 Measurements of yarn surface characteristic on weft tension.

On the three weaving machines the weft tension was measured during picking a raw and waxed cotton yarns Ne 80/1 and the values of the peaks of weft tension were statistically analysed.

2.3 Measurment of the effect of the multi-nozzel pressure and duration of picking on the value of weft tension during picking on air jet weaving machine.

Firstly at constant value of duration of picking the effect of multi-nozzel pressure on the variation in weft tension was measured, secondly the effect of duration of picking on the variation of weft tension was measured at constant value of multi-nozzel pressure. The values of the peaks ofweft tension were statisically analysed.

3- Measurements of the coefficient of frictions for material used

Using the Rotshild friction meter the coefficient of friction (yarn/metal and yarn/ceramic) was measured for raw and waxed yarns at different yarn withdrawal speeds.

4- Experimental results

- Table (1) shows the values of coefficient of friction for cotton yarns, Ne 80/1 (raw and waxed) and Ne 50/1 (raw).
- Fig (2-a) shows the mean values of the peaks of weft tension for yarn from cop-top and cop-base during picking on different types of weaving machines.
- Fig (2-b) shows the variation in the mean values of the peaks of weft tension for raw and waxed weft yarns during picking on the different types of weaving machines.
- Fig (3) shows typical signals for 22 successive picks at three different values of multi-nozzel pressure during picking on the air jet weaving machine.
- Fig (4) shows typical signals for 22 successive picks at three different values of picking time (in form degrees of crank shaft) during picking on air jet weaving machine.
- Fig (5) shows the mean values of the peaks of weft tension under the effect of duration of picking and multi-nozzel pressure.
- Fig (6) shows a comparison between measured and calculated weft tensile stresses at different values of duration of picking time.

THEORETICAL CALCULATION OF WEFT TENSILE STRESSES

During picking on the air jet weaving machine L 5100, the normal adjustment for machine timing in form of degrees of crank shaft is from 75° (start of picking) up to 250° (end of picking). The mean value of weft speed during picking process decrearses with increasing the duration of picking at constant speed of the weaving machine and the contrary occurs. The mean value of weft speed could be calculated as follows:

$$\text{mean speed } (V) = \frac{b}{t} \quad (m/s)$$

where,

b = length of the inserted weft yarn, and
t = time required for picking in sec.

the required time for picking could be calculated as follows:

$$t = \frac{60}{n} \cdot \frac{(\theta 2 - \theta 1)}{360} \quad (sec)$$

where, θ1 = degree of crank shaft at the beginning of picking.
θ2 = degree of crank shaft at the end of picking.
n = picks/min

Calculated example:

n = 850 p.p.m. , b = 1,9 m
θ1 = 75° , θ2 = 250°, 265° and 275°

Usually the weft speed at the end of picking (V1) is 60-70 % from the mean value (V), therefore the weft speed for the corresponding duration of picking are:

V1 = 36.9 , 34 , 32.3 m/s

Using the mathematical relation between weft speed and tensile stress of weft yarn /10/.

$$F\ (cN/tex) = V1\ (m/s) \cdot \sqrt{E} \cdot 100$$

$$(m/s) = \sqrt{(cN/tex)} = \sqrt{(kg.m/s.s)/(kg/m)} = (m/s)$$

where E is the modulus of elasticity of the used weft yarn in cN/tex and F is the weft tenacity during picking on air jet weaving machine. The modulus of elasticity for the used weft thread could be calculated as follows:

$$E = \frac{\text{yarn tension } (\bar{\bar{T}} \text{ in cN}) \text{ at } 2\ \% \text{ elongation}}{2 \times \text{yarn tex}} \times 100\ (cN/tex)$$

= 369 cN/tex (cotton Ne 50/1)

where, $\bar{T} = \frac{T}{n1}$ and $\bar{\bar{T}} = \frac{\bar{T}}{n2}$

T = yarn strength (at 2% extension) in single measurements
$\bar{T}$ = mean value for all single measurements per package (n1 = 100)
$\bar{\bar{T}}$ = mean value for all tested packages (n2 = 13)

DISCUSSION AND CONCLUSIONS

As shown in Table (1) the coefficient of friction yarn/metal and yarn/ceramic for raw cotton yarns Ne 50/1, Ne 80/1 ranged between 0.25 and 0.33. But for waxed yarns Ne 80/1 ranged between 0.11 and 0.21. The coefficient of friction for both cotton yarns (raw and waxed) yarn/metal is lower than yarn/ceramic, and in case of raw cotton yarns, the reduction in the coefficient of friction is 5 % and 19 % for Ne 50/1 and Ne 80/1 respectively. But the reduction in the coefficient of friction between raw and waxed cotton yarns Ne 80/1 for yarn/ceramic and yarn/metal ranged between 38 and 57 % respectively.
By measuring the coefficient of friction, the effect of yarn linear density and yarn withdrawal speed have insignificant effect on the variation in the coefficient of friction.

The yarn position in cop has influnce on the value of weft tension during picking on three type of weaving machines, for all weaving machines the value of weft tension during picking weft yarns from cop top is lower than the weft tension for yarns from cop base, this is due to the increase in yarn hairiness toward cop base which in case of mechanical weft insertion systems act to increase the friction between yarn and picking elements.
But in case of air jet weft insertion system the increase in yarn hairiness leads to increase in the weft withdrawal speed and resulting an increase in the braking force at the end of the picking (max.weft tension), see Fig (2-a). Therefore to improve the quality of fabric the variation in the hairiness of weft yarn must be small as much as possible.

By picking waxed weft yarns on weaving machines with mechanical weft insertion systems, the value of weft tension is significantly reduced, this is due to the reduction in friction between weft yarn and picking elements. The reduction in the value of weft tension ranged between 30 % and 40 % for projectile and rapier weaving machine respectively.
During picking on air jet weaving machine the waxed weft yarn has no influnce on the value of weft tension because the maximum weft tension is due to braking the weft yarn at the end of picking. Due to the low friction between weft yarn and picking elements (yarn accumulator, inner surface of main nozzel and yarn guides) the air pressure could be reduced about 12 %. The reduction in air pressure is due to the automatic regulation of weaving machine to keep it on a constant picking time, the air pressure decreases automatically with decreasing picking time, see Fig (2-b).
On the other hand the use of waxed weft yarns is not common on the weaving machine because the finishing process of the fabric latter would become difficult and affects the quality of the fabric.

From the typical signals of weft tension as shown in Fig (3) the level of weft tension increases with increasing the air pressure of multi-nozzel. The picking speed of weft thread increases with increasing the air pressure of multi-nozzel and this leads to increase in the breaking force (maximum weft tension) at the end of the picking.

Fig (4) shows a typical signal for the level of weft tension at different values of duration of picking , the level of weft tension decreases with increasing the duration of picking . At a constant speed of weaving machine the speed of weft yarn decreases with increasing the duration of picking and this leads to a decrease in the braking force (max. weft tension) of weft yarn at the end of picking.

Fig (5) shows the effects of both duration of picking and air pressure of multi-nozzel on the mean value of the peaks of weft tension. The relation for weft tension against picking time and air pressure of the multi-nozzel is non-linear. The rate of decrease in weft tension is high at a picking time more than 0.0372 sec (equivelant to 190 degrees of crank shaft). While the rate of increase in weft tension is low at air pressure of multi-nozzel more than 3.5 bar.
Therefore to avoid the increase in weft tension due to the increase in the speed of weaving machine the picking time must be high as much as possible and also the air pressure of multi-nozzel must be low.

Fig (6) shows the theoretical and experimental distribution of weft stresses against duration of picking . By calculating the correlation coefficient between duration of picking and both theoretical and experimental weft stresses the following results are given:

- correlation coefficient between duration of picking and theoretical weft stresses is $r = -1$.
- correlation coefficient between duration of picking and experimental weft stresses is $r = -0.9734$.
- correlation coefficient between theoretical and experimental weft stresses is $r = 0.9728$.

The difference between theoretical and experimental results is due to the automatic regulation for the air pressure of the main nozzel by varing the duration of picking , the air pressure of the main nozzel decreases with increasing the duration of picking.

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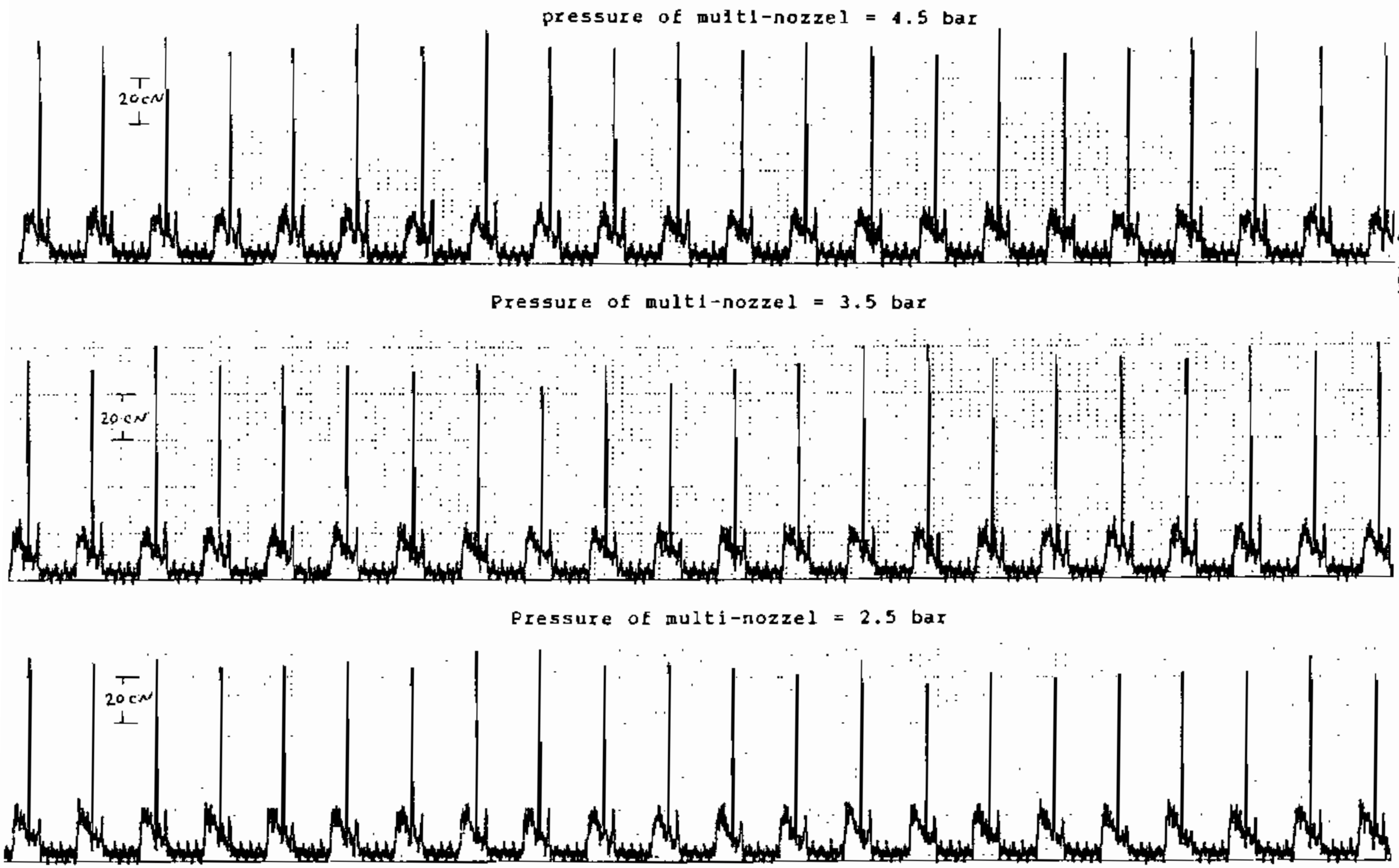
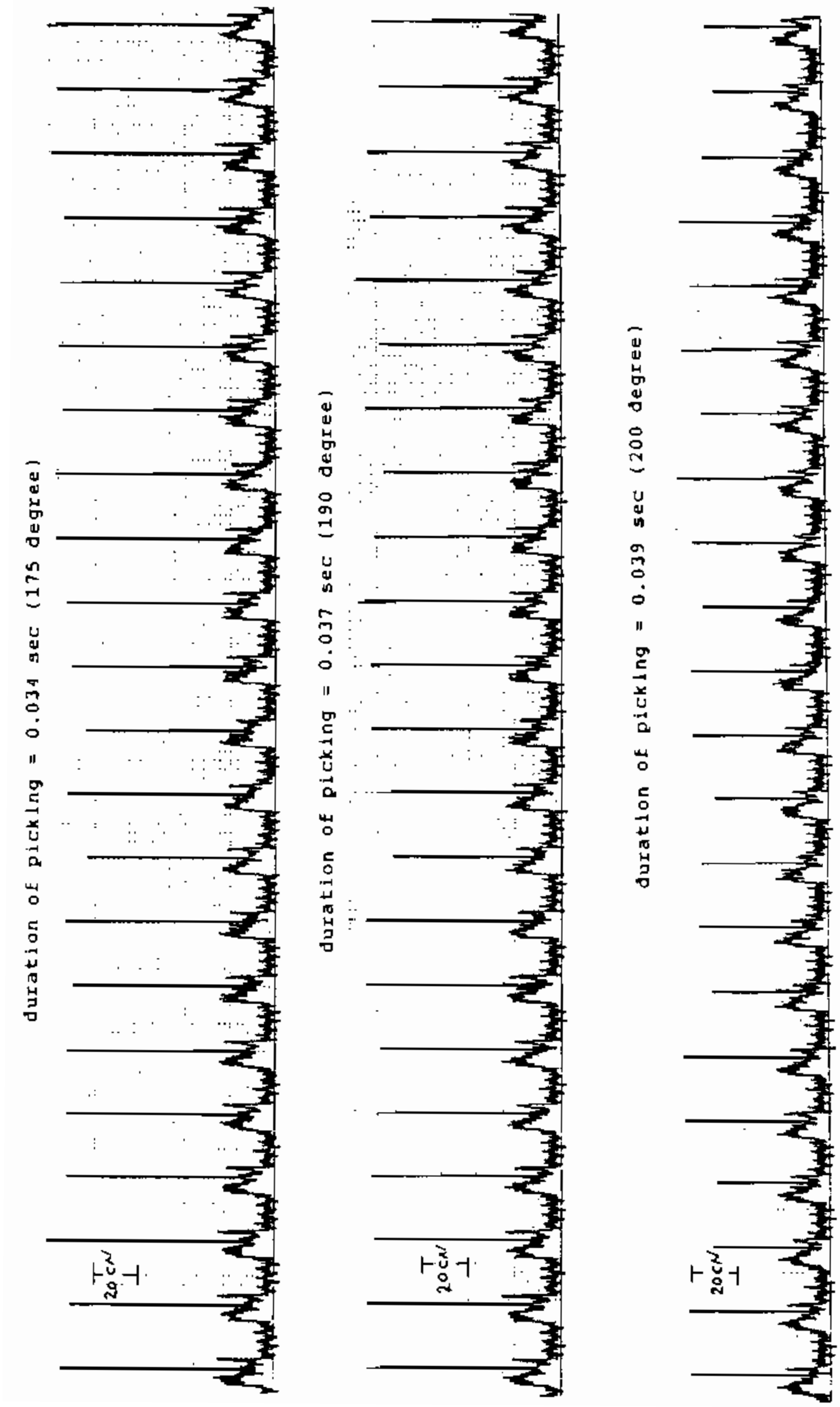
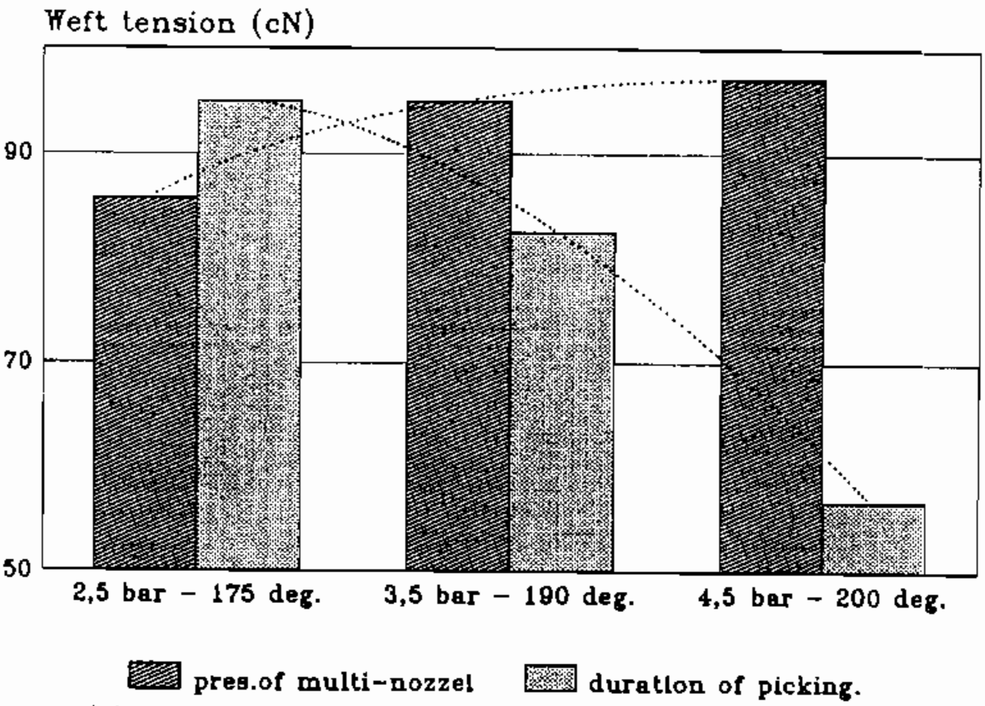


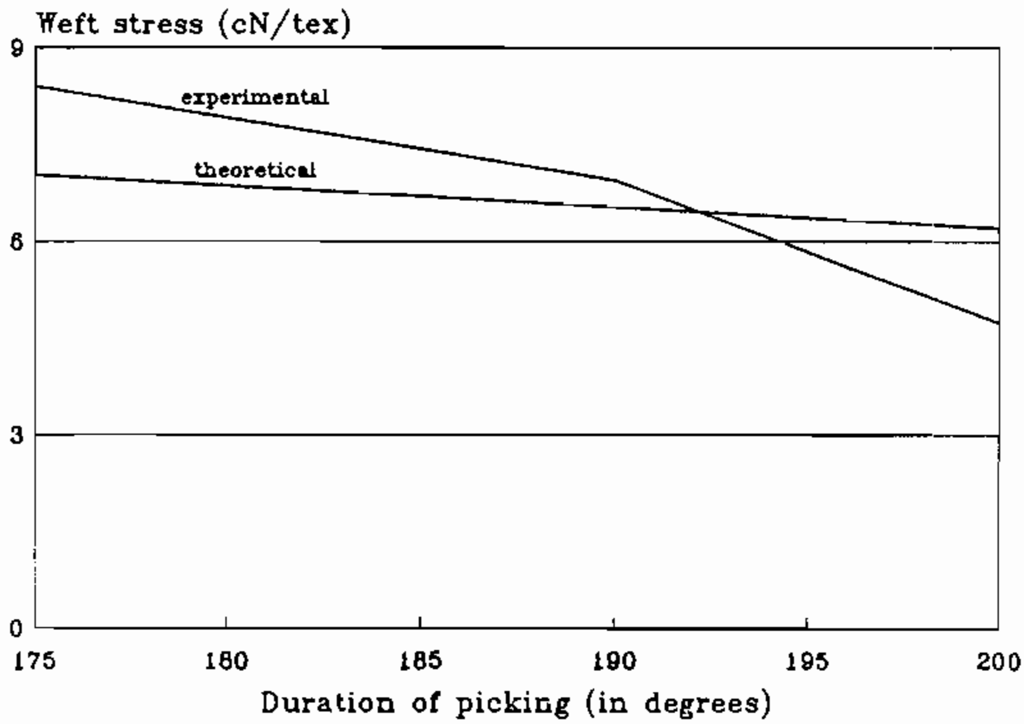
Fig(3):typical signals of weft tension at different values of multi-nozzel pressure (duration of picking = 0.034 sec)



Fig(4): typical signals of weft tension at different values of duration of picking (pressure of multi-nozzel = 3.5 bar)



Fig(5): effect of multi-nozzel pressure and duration of picking (in degrees of crank shaft) on weft tension



Fig(6):comparison between theor.and exper.stresses (air jet)