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A. Shahin
Textile Engineering Department., Faculty of Engineering., El-Mansoura University., Mansoura., Egypt.

A. El-Deeb
Textile Engineering Department., Faculty of Engineering., El-Mansoura University., Mansoura., Egypt.

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STUDY OF SOME AFFECTING PARAMETERS ON WARP STRENGTH IN THE WOVEN FABRIC

By: Shahin, A. and El-Deeb, A.

دراسة بعض العوامل المؤثرة على متانة خيوط السداء فى القماش

الخلاصة:
فى هذا البحث تم دراسة تأثير كل من سرعة ماكينة النسيج (ذات القذف الهوائى) ومشوار الدرأ على انخفاض المتانة لخيوط السداء فى القماش. وذلك من خلال قياس متانة خيوط السداء (المبوشة) قبل استخدامها على ماكينة النسيج ثم قياس متانتها مرة أخرى بعد تنسيلها من القماش المنسوج. كذلك تم قياس الشد الديناميكى لخيوط السداء، بالاضافة الى ذلك تم عمليا دراسة تأثير البوش على تغيير الخواص الميكانيكية لخيوط السداء، وتم حساب معامل الارتباط بين اجهاد قطع الخيط والاستطالة له والذى به يمكن التنبؤ بنسبة الشد الديناميكى.
نظريا تم دراسة الحركات الديناميكية للدرا تحت تأثير تغيير سرعة ماكينة النسيج وطول مشوار الدرأ. وتم الربط بين تلك الدراسة ومدى التغيير فيها على معدل الانخفاض فى متانة خيوط السداء فى القماش. ووجد أن نسبة الاستطالة الاستاتيكية للخيوط مساوية لنسبة الشد الديناميكى لها. وقد وجد أن الزيادة فى كل من سرعة ماكينة النسيج ومشوار الدرأ لهم تأثير على الانخفاض فى متانة خيوط السداء والتى تصل نسبتها الى ١١٪.

ABSTRACT

In this work the effect of weaving machine speed and stroke of heald shafts on woven warp strength was measured. The strength of sized warp threads was measured before weaving process. And the yarn strength was measured for the woven fabric for two different weaving machine speeds (650 and 850 picks/min) . The ravelled warp threads from the woven fabric were choosen for marked threads in the first and last heald shaft.
Also some of the mechanical characteristic of warp threads was measured before and after sizing process.
Theoretically the dynamic motion of heald shaft was derived for air jet weaving machine with a sinsoidal motion for heald shafts. The dynamic motion was calculated at different machine speed and different stroks of heald shafts.
It was found that the machine speed and stroke of heald shafts have influence on the reduction of strength for warp threads in the woven fabric, the reduction is up to 11%.

1 INTRODUCTION

During weaving process the warp threads are under variable stresses. The value of these stresses is affected by many parameters such as:
- stroke of heald shafts
- speed of the weaving machine
- type of motion for the reciprocating elements on the weaving machine.

Because the warp yarns are non-perfect elastic, the weaving process act to reduce its elasticity. Erkens [1] stated that many parameters have influence on the elasticity of warp yarns, the following results were found by measuring the effect of some parameters using a model with reciprocating motion for yarn.
- The residual extension decreases with increasing the number of cycles , yarn tension and stroke of cycle.
- The residual extension in yarn affected by the physical properties of yarn such as fibre length , fibre cross section and yarn blend ......etc.

Krause [2] and Schaheen [3] stated that , the warp yarn in the last heald shaft during weaving process are more extended than the warp yarns in the first heald shaft and this is due to the excess stresses on warp threads in the last heald shaft.
It was measured in this work the effect of some parameters such as speed of weaving machine and stroke of heald shaft on the strength of warp threads in the woven fabric.

2 THEORETICAL:

2.1 Dynamic movement of heald shaft

2.1.1 Nomenclature

- $X(\theta)$: displacement of heald shaft at angle of rotation θ
- H : maximum stroke of heald shaft
- θ : angle of rotation at general position for heald shaft
- $\theta 1$: total angle of rotation at the maximum displacement of heald shaft
- ω :angular velocity of the cam for shedding
- $V(\theta)$:speed of heald shaft at angle θ
- $A(\theta)$:acceleration of heald shaft at angle θ
- Vmax.:maximum speed of heald shaft
- Amax.:maximum acceleration of heald shaft

The used weaving machine has a positive cam with a sinsoidal profile and the general equation to describe the outstroke for the angle $0 < \theta < \theta 1$ could be described as follows:

$$X(\theta) = a.\theta - d . \sin k.\theta$$

the constants a , d and k could be determined by using the boundary conditios for the motion then,

at $\theta = 0$ and $\theta = \theta 1$ the speed of heald shaft is equal zero, and

at $\theta = \theta 1$ the displacement $X = H$

then the speed $V(\theta)$ and acceleratin $A(\theta)$ could be derived as follows:

$$X(\theta) = H/\theta 1 . \{ \theta - \theta 1/2.\pi . (\sin 2.\pi . \theta/\theta 1) \}$$

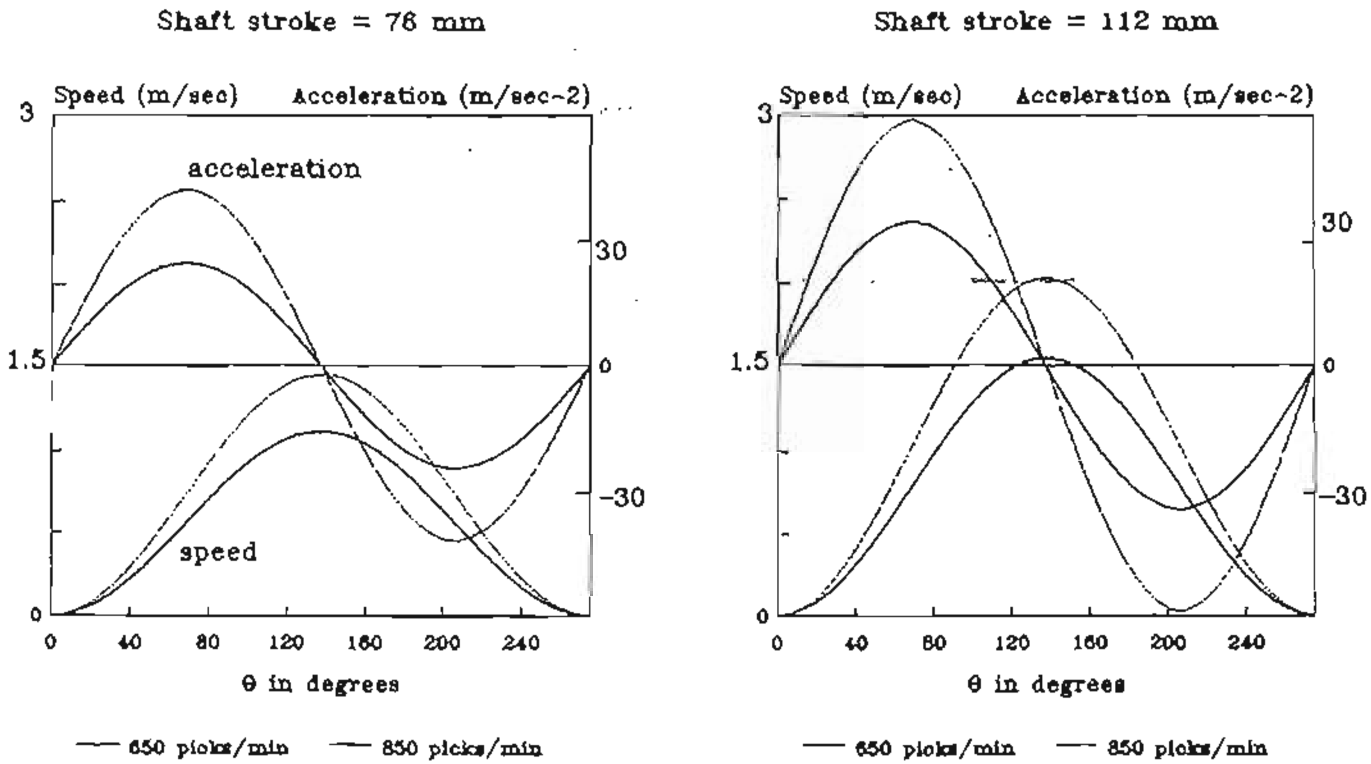
$$V(\theta) = \omega . H /\theta 1 . \{ 1 - \cos 2.\pi \theta/\theta 1 \}$$

$$A(\theta) = (\omega^2 . H . 2.\pi/\theta 1^2). \sin (2.\pi .\theta / \theta 1)$$

The behaviour of speed and acceleratin of heald shaft as a function from angle θ could be represented for different values of machine speed and stroke of heald shaft, Fig.(1) shows the speed and acceleration for heald shaft on air jet weaving machine with the following data:

- speed of weaving machine = 650 and 850 picks/min
- stroke of first heald shaft = 76 mm
- stroke of last heald shaft = 112 mm
- total anglular displacement = 275 degree

Fig(1):effect of shaft stroke & machine speed on dynamic motion for heald shaft



2.2 Effect of shaft position on static warp extension

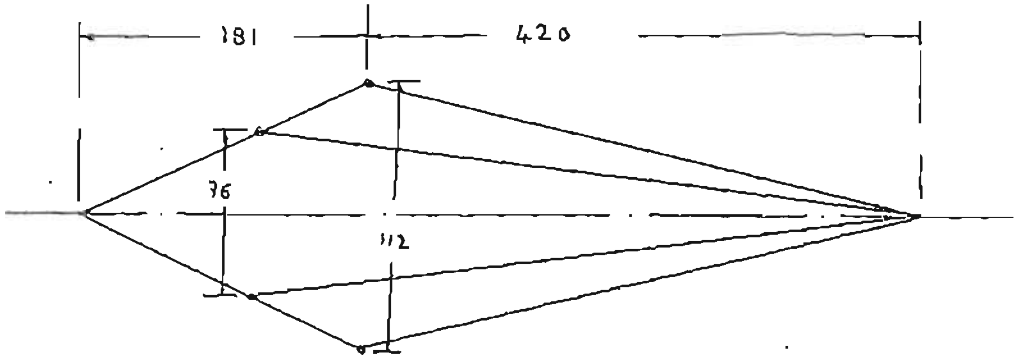


Fig.(2) geometrical dimensions of shed

As shown in the geometrical dimensions of shed to obtain a clear shed the first heald shaft must be displaced smaller stroke than the last heald shaft, the static warp extension could be calculated as followes:

Extension in the first heald shaft is:

Total extension = (481.5 + 126.82) - 601 = 7.32 mm (= 1.22 %)

and for last heald shaft is:

Total extension = (423.7 + 189.46) - 601 = 12.16 mm (= 2.02 %)

The last heald shaft has more extension than the first heald shaft.

3 EXPERIMENTAL

3.1 Specification of weaving machine and material used:

- Air jet weaving machine............ up to 850 picks/min
- Read width......................... 190 cm
- Ends/cm............................ 47, cotton Ne 50/1
- Picks/cm........................... 28, cotton Ne 50/1
- No. of heald shafts................ 6
- Fabric structure................... plain weave

3.2 Measurement of the characteristics of warp yarns before and after sizing
Using the apparatus Instron 4500 the single end strength, elongation and work of rupture were measured for warp yarns before sizing, the mean value was calculated from 100 single test.
To measure these values for sized yarns 150 samples were choosen across the width of warp beam from 15 positions (10 tests per positions). The mean values for these measurements were calculated from the total number of samples.
To determine the correlation between strength and elongation across the width of warp beam the mean value was calculated per position.

3.3 Measurement of the dynamic warp tension during weaving process

Using the electronic measuring apparatus (DEFAT) the mean value of maximum dynamic warp tension (due to bottom shed) was measured at the middle of warp sheet during weaving with two different speeds (650 and 850 picks/min). This mean value was calculated from the single values for ten successive warp threads marked in the first and last heald shaft. For every single warp yarn the following values could be calculated:

- mean value of tension for top and bottom shed
- mean value of tension for top shed
- C V % of tension in top shed
- mean value of tension for bottom shed
- C V % of tension for bottom shed
- maximum tension during beating-up (top shed)
- C V % of tension for max. beating-up (top shed)
- maximum tension during beating-up (bottom shed)
- C V % of tension for max. beating-up (bottom shed)
- mean value of minimum tension
- C V % of minimum tension
- mean value of maximum tension
- C V % of maximum tension
- difference between maximum and minimum tension

3.4 Measurement of warp strength in the woven fabric

Twenty warp threads were marked at the middle of warp sheet in the first and last heald shaft. After weaving with two different speeds the marked warp threads were ravelled from the woven fabric to measure the strength of these threads.

3.5 Representation of the results

- Fig(1) shows the theoretical speed and acceleration for first and last heald shaft at 650 and 850 picks/min.
- Fig(2) geometrical dimensions of the shed for air jet weaving machine L5100.
- Fig(3a & 3b) shows the typical curve of strength - elongation for warp threads before and after sizing.
- Fig(4) shows the comparison between breaking strength, breaking elongation, work of rupture and modulus of elasticity for warp yarns before and after sizing.
- Fig(5) shows the correlation between warp tenacity and elongation % for cotton Ne 50/1.
- Fig(6) shows the reduction in warp strength due to the effect of the variation in shaft stroke and speed of weaving machine on warp strength.

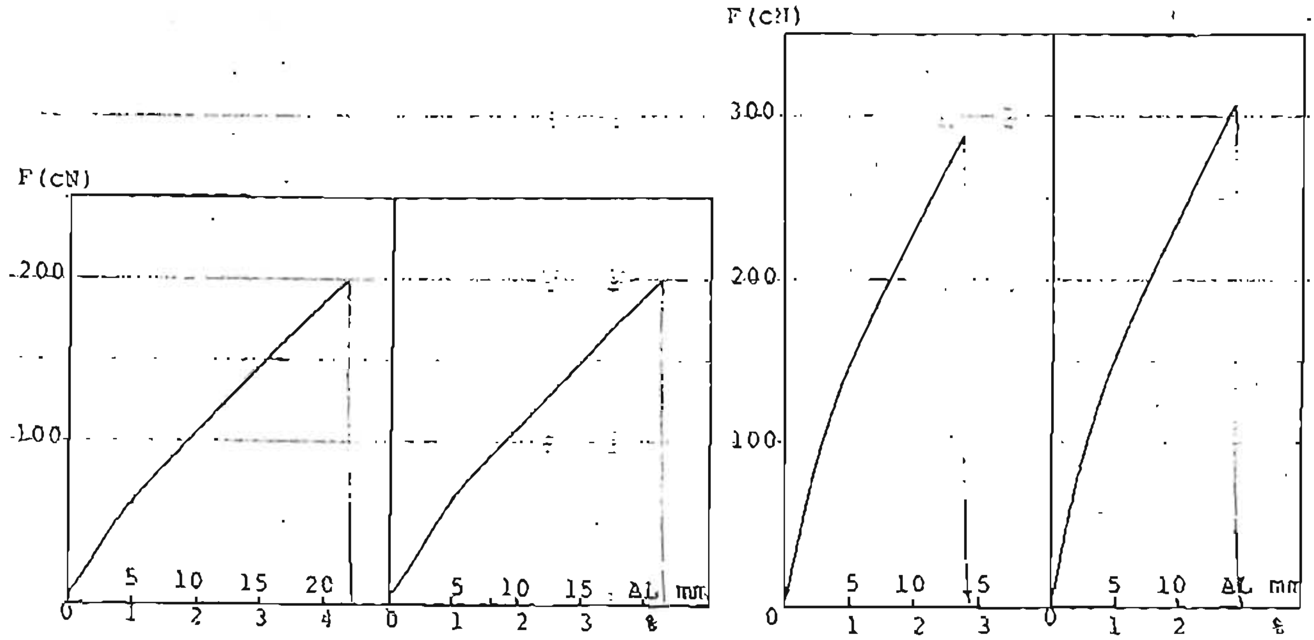
- Table(1) shows the maximum values of speed and acceleration for heald shaft at different speeds of weaving machine and shaft stroke.
- Table(2) shows the mean value of the maximum dynamic warp tension at two different machine speed for first and last heald shaft.

Table(1): speed and acceleration for heald shafts

	speed (m/sec)		acceleration (m/sec^2)	
picks/min	650	850	650	850
first shaft	1.08	1.41	24.05	41.13
last shaft	1.59	2.08	35.4	60.6

Table(2): max. dynamic warp tension and static warp elongation

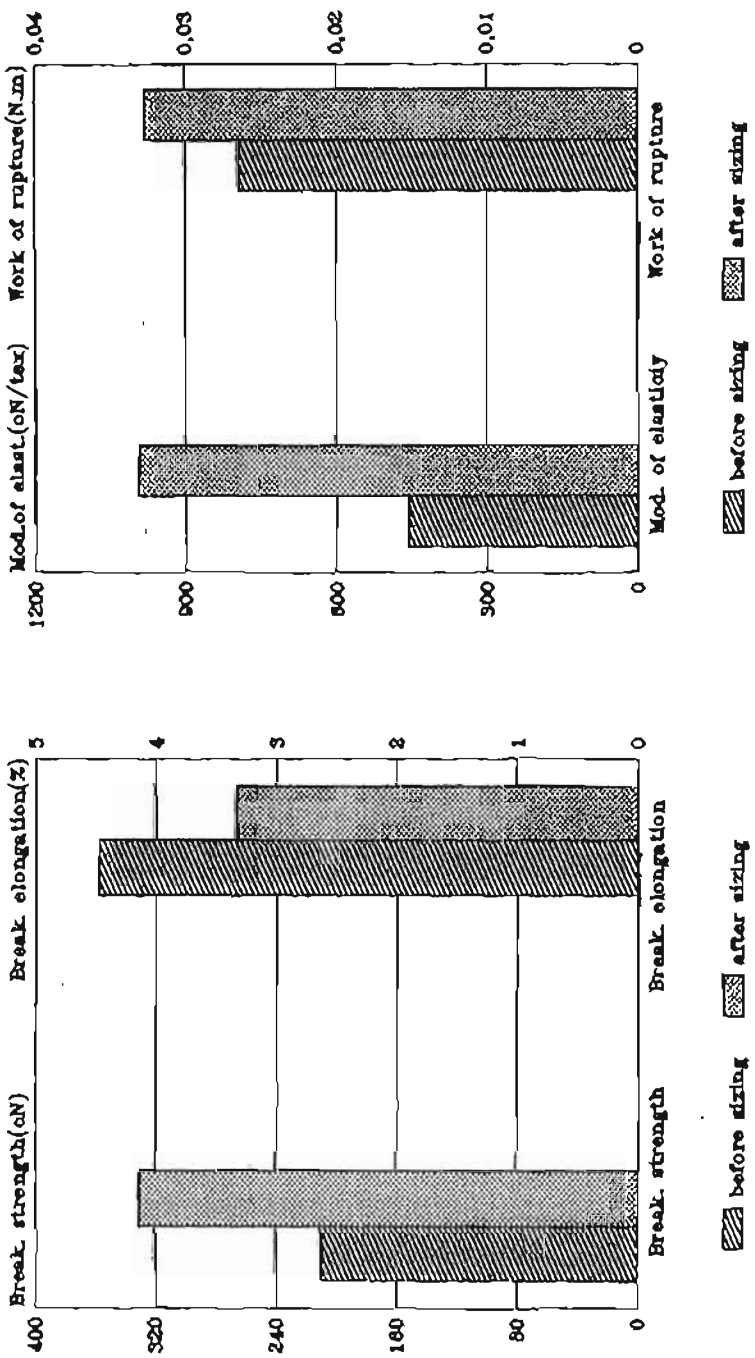
	first heald shaft		last heald shaft	
machine speed (picks/min)	650	850	650	850
max.dynamic tension (cN)	50	46	88	76
static elongation %	1.22		2.02	



(a) before sizing (b) after sizing

Fig(3): typical curve for strength - elongation

Fig(4):characteristics of yarn before & after sizing



4 DISCUSSION

- The sizing process has influence on the physical and mechanical properties of warp yarns, the variation in the mechanical properties is:

increase in yarn strength	=	57 %
decrease in yarn elongation	=	- 25 %
increase in work of rupture	=	27 %
increase in modulus of elasticity	=	118 %

- The sizing process has high influence on yarn modulus of elasticity, this is due to the increase in yarn strength and decrease of its elongation at the same time.

- To obtain a clear shed for the weaving machine, the last heald shaft must be moved longer stroke (112 mm) than the first heald shaft (76 mm), see Fig (2). This variation in shaft stroke has influence on many parameters such as dynamic warp tension, warp extension and dynamic movement of heald shaft.

- From the theoretical calculations for the dynamic movement of heald shaft it was found that the percentage increase in the speed of heald shaft due to the increase in machine speed from 650 to 850 picks/min is 31 %, and the percentage increase in shaft acceleration is 71%. At constant speed of weaving machine the percentage increase in the speed and acceleration of heald shaft due to the increase in shaft stroke is 47 %, see Fig (1) and Table (1).

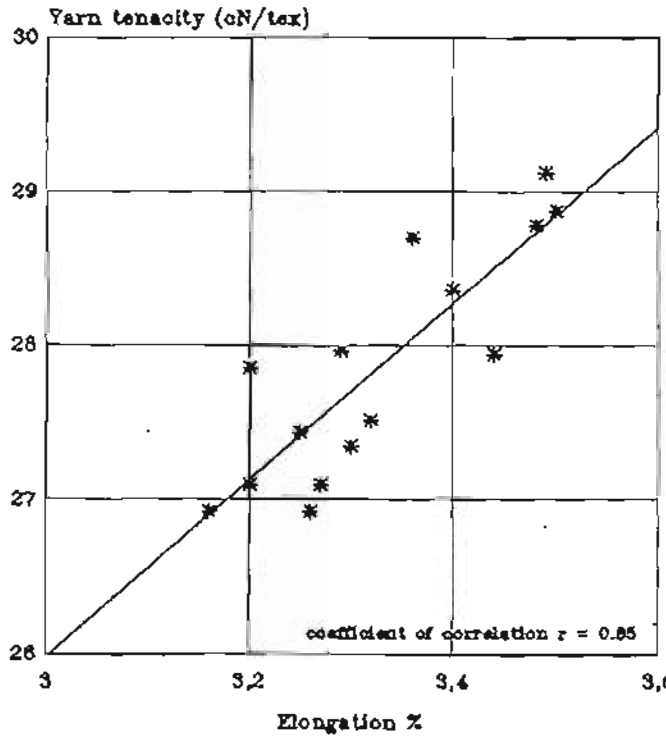
- At constant stroke of heald shaft the variation in the speed of weaving machine has no influence on the maximum dynamic warp tension (in longitudinal direction). But with increasing the stroke of heald shaft the percentage increase in dynamic warp tension ranges between 65% and 76 %. The increase in shaft stroke tends to increase in warp elongation and this acts to increase in warp tension, see Table (2).

- Due to the high correlation between tenacity and elongation % (r= 0.85), see Fig (5) the percentage increase in static warp elongation is proportional to the percentage increase in maximum dynamic warp tension.

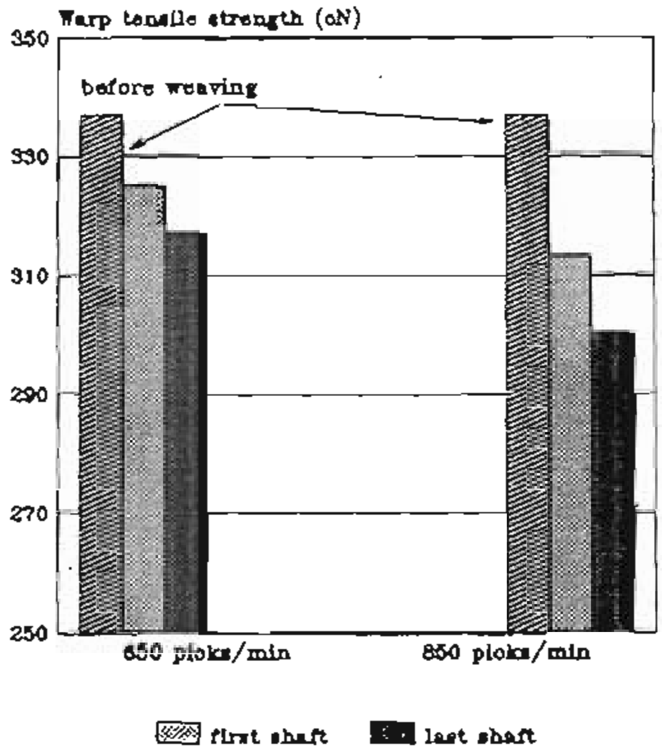
- By comparing the strength of warp threads before and after weaving it was found that both machine speed and shaft stroke have influence on the reduction of thread strength after weaving, see Fig (6). The reduction in thread strength due to the increase in machine speed (at shaft stroke = 112 mm) is higher than the effect of the increase in shaft stroke (at 850 picks/min). And this is due to the high effect of the dynamic stresses in crosswise direction for warp threads.

- Although the variation in the speed of weaving machine has no influence on the maximum dynamic warp tension (longitudinal direction), the strength of warp threads in the woven fabric was affected by the crosswise stresses of warp threads (due to the dynamic movement of heald shaft).

Fig(5): correlation between tenacity and elongation % for sized warp threads (cotton Ne 50/1)



Fig(6): effect of shaft stroke and speed of weaving machine on warp strength



5 CONCLUSION

- The difference in the strength of warp threads in the woven fabric due to the variation in shaft stroke and machine speed acts to decrease the total fabric strength in warp direction.

- By determining both the ratio of warp static elongation for heald shafts and the correlation coefficient for tenacity - elongation, the ratio for dynamic warp tension could be determined.

-To avoid the difference in the reduction of thread strength in the woven fabric the stroke of heald shaft must be small as allawable and as possible, and the high increase in the speed of weaving machine must be limited.

- The structure of sizing material must have a component act to keep the warp yarn with its initial elasticity.

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