# *To Analyze the Twist Loss in Weft Yarn During Air-Jet Weaving and Its Impact on Tensile Properties of Fabric*

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## Abstract:

This project work deals with the behavior of weft yarn in terms of twist during air jet weaving. The twist in the yarn decides its structure and strength and when it is in fabric as a weft, its twist having impact on fabric properties like strength, drape, dye-up take etc. The trials are conducted for the analyzing the effect of single hole and shower type relay nozzle on the twist of the weft yarn for 13.12 Tex (45'S Ne) (CVC-Chief Value Cotton) yarn and same construction of fabric. The multi hole relay nozzle is results in higher twist loss than the single hole relay nozzle. The effect also observed for the weft way tensile properties at left and right side of the fabric. At right side of the fabric lesser strength has been found than the left side of the fabric. It is found the air pressure of the nozzles is directly proportional to the twist in the weft yarn.

The package from loom shed has been tested for actual twist in the weft. Afterwards the weft extracts from the fabric and tested for twist at both left and right side of the fabric. Similarly the left and right side used for measuring the tensile properties of the fabric.

## Introduction:

Air jet weaving is a type of weaving in which the filling yarn is inserted into the warp shed with compressed air. Upon release of the filling yarn by the stopper, the filling is fed into the reed tunnel via tandem and main nozzles. The tandem and main nozzle combination provides the initial acceleration, where the relay nozzle provides high air velocity across the weave shed. Profiled reed provides guidance for the air and separates the filling yarn from the warp. The insertion medium mass to be accelerated is very small, relative to the shuttle, rapier or projectile machines, which allows high running speeds.

A typical timing dig. of main and relay nozzles is shown in the following chapter. The timed groups of relay nozzles blow air on the tip of the yarn across the machine width. As result, the yarn is pulled by the air at the tip (rather than pushed from behind) throughout the insertion, minimizing the possibility of buckling which may cause weaving machine stops. This also assures the lowest possible air consumption.

Twist level plays an important role in the behavior of yarn by creating lateral forces which prevent the fibers in the yarn from slipping over one another. These forces bring the fibers closer which make the yarn more compact. High twist level increases the insertion time since twist reduces the diameter of yarn and makes the yarn surface smoother. The propulsive force decreases with a decrease in the diameter and the smoother surface reduces the friction between the yarns surface and air. As a result; yarns with low twist have higher velocities. There is no significant difference between S and Z twist for air jet insertion.

Freedom of the filling to untwist during insertion results in twist loss during weaving which affects the strength of the fabric; its dye up take and possibly other properties. There is minimum twist multiple below which the filling yarn disintegrates because of the air pressure. Plied yarns give longer insertion times in air jet filling insertion than one ply yarns with the same count. The reason is that additional twist makes the yarn surface smoother and reduces air friction

## Review of literature:

### Twist and twist measurement:

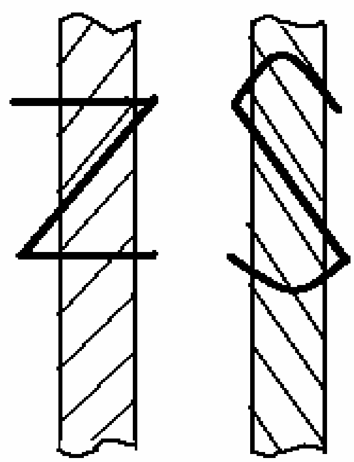
- “Twist is the measure of the spiral turns given to a yarn in order to hold the constituent fibers or threads together”. (Skinkle)
- “When a strand is twisted the component fibers tend to take on a spiral formation, the geometric perfection of which depends on their original formation” (Morton).

- "Twist may be defined as the rotation about the yarn axis of any line drawn on the yarn which was originally, i.e. before twisting, parallel to the yarn axis". (wool Res.Vol.3).
- "Twist: The spiral disposition of the components of a thread which is usually the result of relative rotation of the two ends" (F.Text.inst.38, P626 (1947)).

**Twist direction:**

The direction of twist at each stage of manufacture is indicated by the use of the letters "S" or "Z" in accordance with the following convention:

A single yarn has "S" twist if, when it is held in the vertical position, the fibers inclined to the axis of the yarn conform in direction of slope to the central portion of the letter S. similarly, the yarn has "Z" twist if the fibers inclined to the axis of the yarn conform in direction of slope to the central of the letter Z.



## The function of twist in yarn structure:

Without twist a strand of fibers has very little strength, and in the first instance a yarn must have sufficient tensile strength to withstand the stresses of preparation and fabric manufacture. It is useful to note here that twist less yarn has been employed as weft in fabrics has shown reasonable weft way strength. This one example illustrates that the yarn properties when *in fabric form* are not necessarily those demanded by the methods used in preparation and manufacturing process. Nevertheless, the main function of twist is to give coherence to the yarn. The theories of yarn geometry and its relation to mechanical properties are still being developed, but some general conclusions have been published and the notes which follow are condensed from Gregory's papers in Journal of the textile institute.

In order to develop strength in a twisted strand of discontinuous fibers, such as a cotton yarn, and so resist breakage, the individual fibers must grip each other when the strand is stressed. This cohesion arises mainly from the twist, which presses the fibers together as the stretching force is applied and so develops friction between adjacent fibers. The pressure results from stressing the twisted strand and has its origin in the tension applied to the curved spiral lines of the individual fibers. It is important to realize that the lateral pressure has no separate existence until the twisted element is stressed.'

"In a book *An Introduction to the Study of Spinning,* Morton comments on this topic:

'We have the somewhat paradoxical condition in which the tension which tends to pull the fibers apart induces at the same time a state of inter-fiber pressure that tends to hold them together. Which of the two tendencies gains the upper hand depends on the angle of the spiral. If the angle is small, i.e. if the twist is low, the fibers can be made to slide past one another, but if it is large they cannot and the only effect of increasing the tension is, in the end, to rupture the strand by breaking the component fibers'.

## Transverse forces acting on yarn:

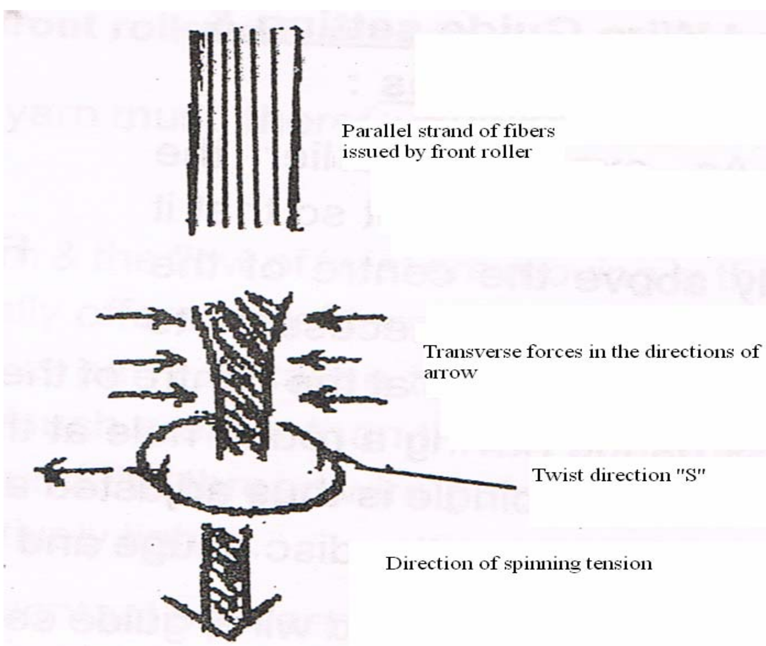



**Fig.5.Transverse forces and yarn compression**

## Torque:

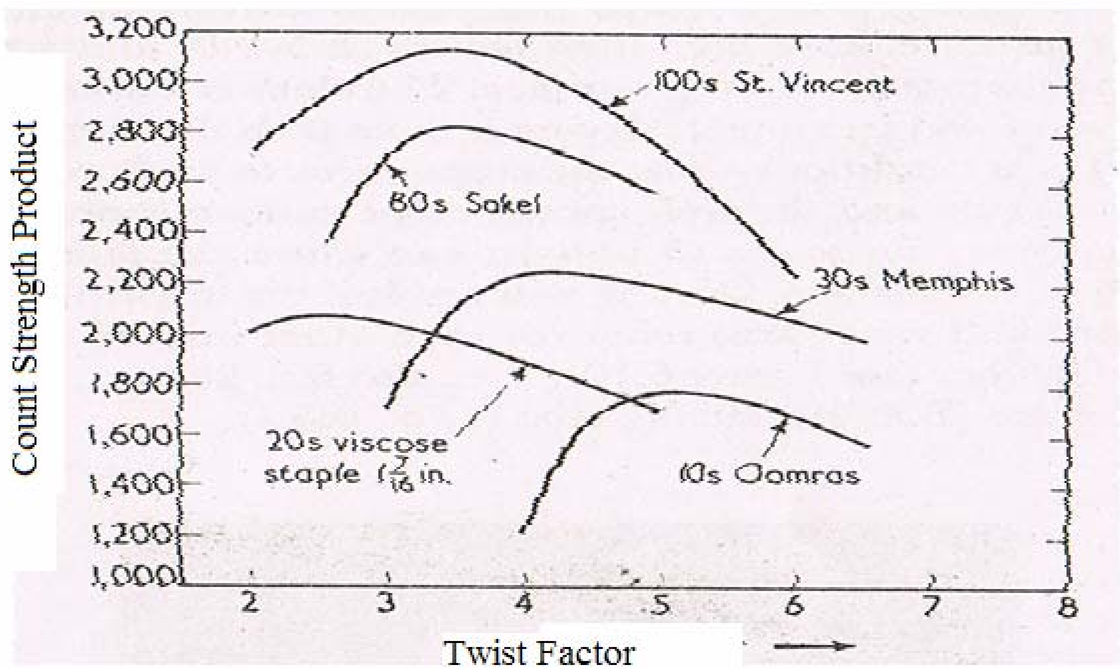
The amount torque that could be introduced was limited, by the torsional stiffness of the yarn tail. Excessive torque made the yarn tail snarl despite the effects of centrifugal forces and elements of the yarn moved rapidly inwards where they could no longer pick up fibers. The torque is stored into the yarn and it is released during air jet insertion resulting in twist loss in weft yarn.

## Twist and yarn strength:

It has been known for many years that an increase in the amount of twist produces an increase in the yarn strength, and that this effect holds only up to a certain point beyond which further increase in twist causes the yarn to become weaker. Referring again to Gregory's paper:

'In order to develop the maximum strength in the twisted strand, a compromise must be reached between the increasing cohesion of the fibers as the twist is increased, and a decrease in the effective contribution to the strength v twist curve for yarn elements can thus be divided broadly into two sections : (1) a low twist region in which the effect of cohesion out-weighs that of obliquity, giving rise to an increase in strength, slow at first up to the point at which fibers break ; (2) a high twist region in which further increase in cohesion no longer produces an increase in strength since the majority of the fibers break, whilst the increasing inclination of the fibers causes the strength to fall. The division between the two regions corresponds to the twist at which the maximum strength is realized. At this twist the greater proportion of the fibers break'.

Twist factor and strength product shows in following graph,




**Some effects of twist on fabric properties:**

The effects of twist on the characteristics of fabrics cannot be covered in a few paragraphs; therefore the remarks which follow serve merely as an indication of the importance of twist in the yarns from which the fabric is constructed. By varying the amount and direction of twist the fabric designer can achieve a variety of fabric effects. Some of these are visual, some are concerned with handle and drape, and some are mechanical, e.g. related to strength or resistance to abrasion.

One example of a visual effect is the 'shadow stripe'. Suppose a cloth is woven with the warp threads in alternate bands of S and Z twist. A subdued stripe effect is observed in the finished cloth due to the difference in the way the incident light is reflected from the two sets of yarns. In a way, this effect is similar to that seen when a lawn has been moved and rolled.

The twill line in fabrics based on the twill weave can be subdued or brought into greater prominence by choice of twist direction. For example, if the warp of a twill has Z twist and the twill line runs 'down to the left', then the use of an S-way weft subdues the twill line. Conversely, the use of a Z-way weft will produce a bolder twill line.

A twisted yarn tends to untwist or assume a configuration in which a state of equilibrium is attained. Highly twisted yarn is ‘lively’ and tends to twist upon itself and produce ‘snarls’. Fabrics made from highly twisted yarns will possess a lively handle. Crepe yarns, for instance, have high twist factors (5.5 - 9.0) and are used to obtain the characteristic crepe surface. The cloth is woven and afterwards given a wet treatment; drying is done with the cloth free from tension. These conditions allow the crepe yarns to curl up and relax; shrinkage occurs and the well known crepe surface is produced.

The tendency for yarns to untwist can cause the fabric to curl, especially at corners. Curling will result if the untwisting couples of the warp and weft yarns reinforce each other instead of counteracting each other. See following figure, ( See also B.S. 2888 : 1957,curl in Textile Fabrics. (B.S.Handbook No.11, p.186.)).

The complex relationships between fiber properties, yarn properties, and fabric properties have been studied by many textile research workers, but as yet simple practical formulae are not available. It is doubtful if simple relationships will be established because of the number of variables which influence the properties of the finished fabric. Twist is by one of these variables. Nevertheless, much can be learnt from experience and experiment, and work in this field has shown that the twist factors used in the yarns influence such fabric properties as tensile strength, tearing strength, resistance to abrasion, handle, and so on.

## Insertion configurations:

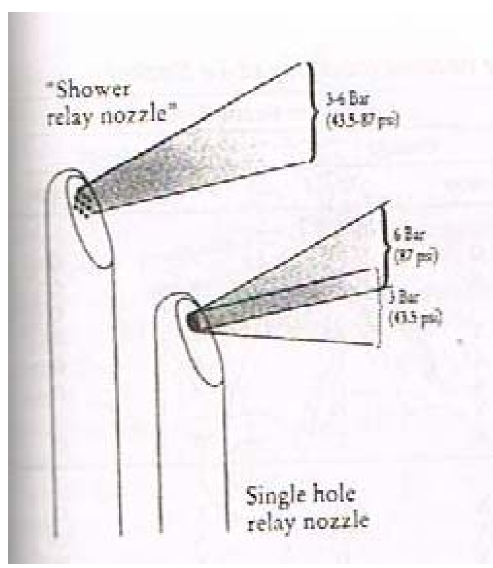
Three different systems have been used mainly on commercial air-jet weaving machines:

1. Single nozzle, confusor guides and suction on the other side.

2. Multiple nozzles with guides.

3. Multiple nozzles with profiled reed.

A relay nozzle can have a single hole or multiple holes arranged in the direction of yarn flight as shown in the following figure. The function of the



nozzle is to increase the kinetic energy of a fluid. The multi hole relay nozzle is also called a shower nozzle. The multi hole relay nozzle gives the uniform distribution of the air flow and it also having the horizontal and vertical blow angle.

### Timing for the nozzles:

A typical timing diagram of main and relay nozzle is shown in figure. The timed groups of relay nozzles blow air on the tip of the yarn across the machine width. As results, the yarn is pulled by the air at the tip (than pushed from behind) throughout the insertion, minimizing the possibility of buckling which may cause weaving machine stops. This result the tip of the yarn is contact with air pressure for longer times which results in higher twist loss at the right side tip of the weft yarn than left side. This results in lesser tensile strength in weft direction at right side than left side.

## Plan of work:

### Materials:

The study conducted for different types of yarns and looms. These are as follows,

1.13.12 Tex (45’s Ne) C.V.C. yarn: Effect of Shower type and single hole relay nozzle.

2.13.12 Tex (45 Ne) C.V.C. yarn: Effect of twist loss on tensile properties at left and right side of fabric.

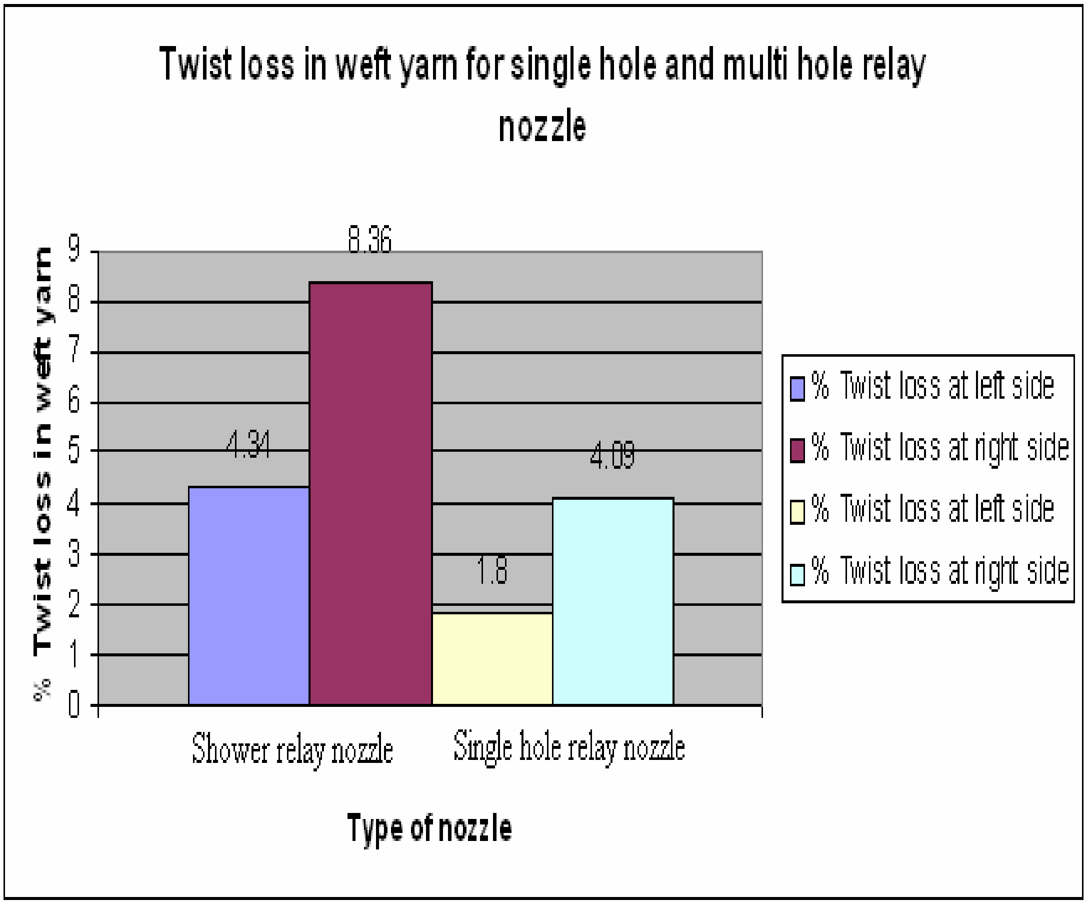
3. 9.84 Tex (60's Ne) combed yarn: Effect Air pressure on twist loss of weft yarn.

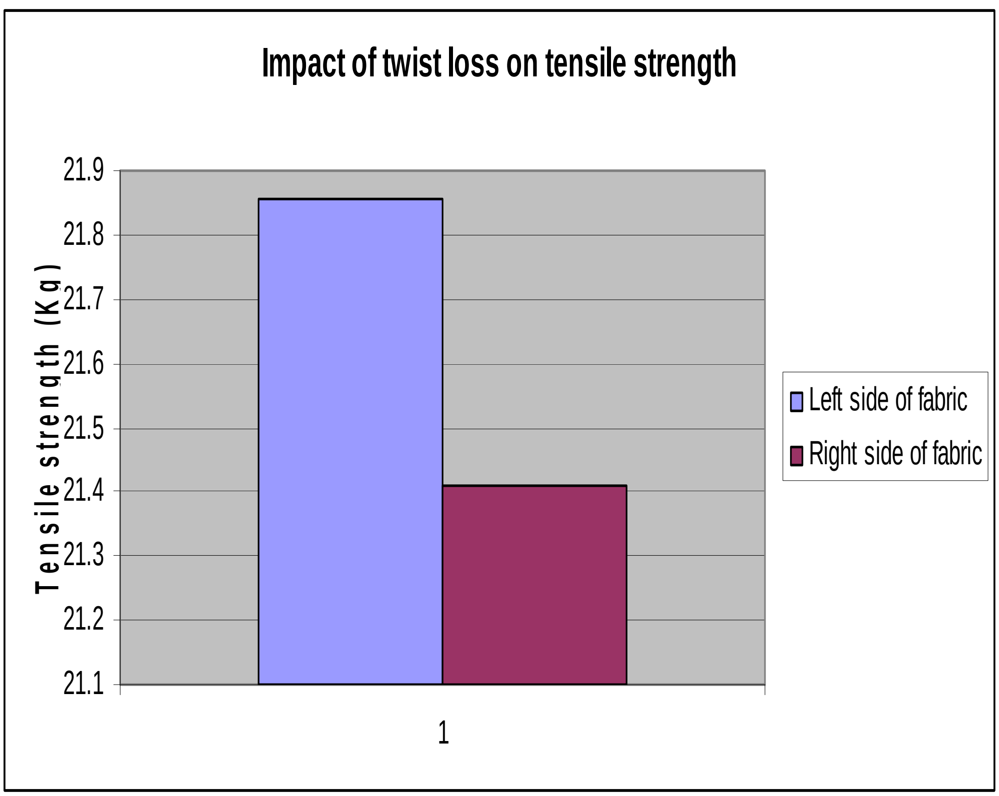
### Methods:

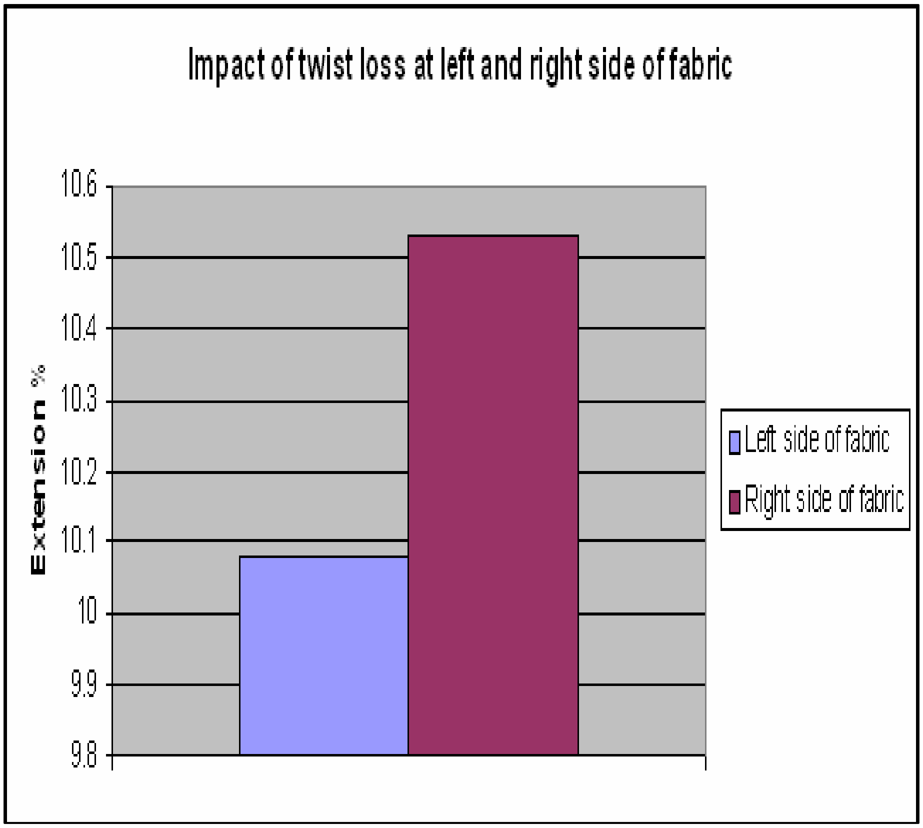
The all above trials are conducted as per following procedure,

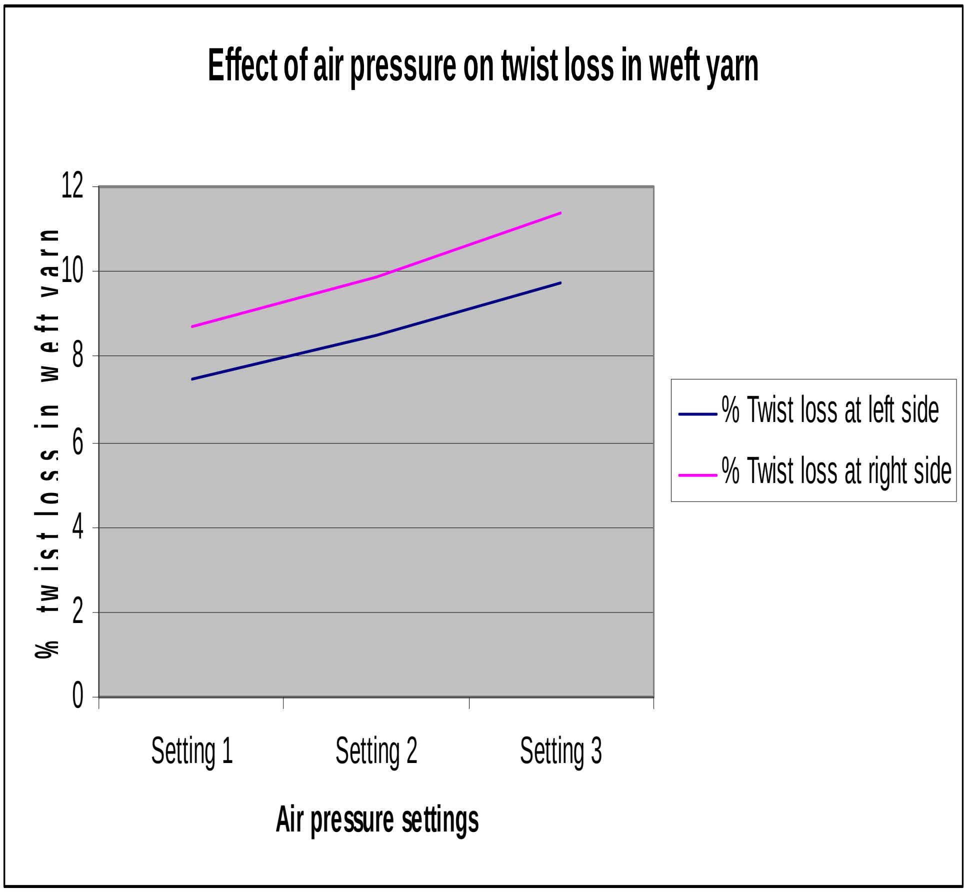
1. At start, the weft package from loom shed has been collected.
2. Then the fabric from same loom has been collected.
3. The twist measured as TPM, on Electronic Twist Tester in QA.
4. The actual TPM measured from package, about 50 readings were taken.
5. For fabric, TPM measured at left and right side of fabric. The weft yarn removes from fabric.
6. The left and right side fabric tested for tensile strength. The no. of samples tested is 15.
7. Similarly, all trials have been conducted.

## Summary and Conclusion:




Impact of twist loss at left and right side of fabric
10.6
10.5
10.4
10.3
10.2
10.1
10
9.9
9.8
Extension %
Left side of fabric
Right side of fabric




**Summary:**

**Study for**

**Twist loss for single hole and multi hole Relay nozzles:**

| | Picanol loom (Shower type relay nozzle) | Toyota loom (Single hole relay nozzle) |
|---|---|---|
| % Twist loss at left side | 4.34 | 1.8 |
| % Twist loss at right side | 8.36 | 4.09 |

**Effect on fabric tensile strength at left and right side of the fabric:**

| Left side of fabric | | Right side of fabric | |
|---|---|---|---|
| Tensile strength(lbf) | Extension % | Tensile strength(lbf) | Extension % |
| 21.85 | 10.08 | 21.40 | 10.53 |
| % variation in strength | | 2.03 | |
| % variation in extension | | 4.46 | |

**Effect of Air pressures on twist loss in weft yarn:**

| | Setting 1 | Setting 2 | Setting 3 |
|---|---|---|---|
| % Twist loss at left side | 7.44 | 8.48 | 9.75 |
| % Twist loss at right side | 8.74 | 9.89 | 11.38 |

## Conclusion:

The results of the project conclude that the higher twist loss occurs in the shower type (multi hole) relay nozzle as compare to single hole relay nozzle. In shower type relay nozzle it is found that the around 4.34 % and 8.36% twist loss where in case of single hole relay nozzle is 1.8% and 4.09% twist loss at left side and right side of fabric respectively.

It can be concluding that variation in twist loss at left side and right side of fabric also affects the strength throughout the width of fabric. It results that lesser strength found around 2.03% and higher extension around 4.46% at right side of fabric.

The effect of air pressure analyze on twist of weft yarn. As air pressure of main and relay valves increases the twist loss in weft yarn increased. The twist loss in weft yarn is directly proportional to air pressure.

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ACIMIT
*Italian Association of Textile Machinery Producers* ***Moral Body***

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