STUDY ON MANUFACTURING PROCESS OF LENO WEAVE BY MODIFICATION OF HAND LOOM

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Abstract

Leno weave is a technical term in textile engineering. Among the different weave structure, leno weave is exclusive because at present leno weave structure is used in geo-textile purpose. In this project the authors studied about the leno weave structure and how to modify hand loom to produce leno fabric without dobby shedding mechanism. Leno weave structure is different from normal plain weave structure. Leno weave is a weave in which the warp yarns do not lie parallel to each other. There are two types of warp called doup yarn and ground yarn. Doup yarn and ground yarn cross one another alternatively. Generally leno weave is produced with the help of dobby shedding mechanism. It is not possible to introduce dobby shedding mechanism in hand loom. Some modification of hand loom were done such as arrangement of harnesses, heald wire having two heald eye, coarser reed count, slackener mechanism and arrangement of paddles in the ordinary hand loom. There are four harnesses were used in this modified hand loom. First two harnesses were ordinary type called back harness and ground harness and last two harnesses were called standard harness and doup harness correspondingly. Back and ground harnesses comprise doup end and ground end respectively. The Standard harness comprises double eye heald wire and the doup harness contains nylon heald wire which passes through double eye heald wire of standard harness. This combination makes a loop. The loop pulls up the doup end under the ground end introduces a stress. For minimizing stress, slackener mechanism was used.

Key words: Leno weave, hand loom, harnesses, slackener mechanism, coarser reed count

Introduction

The history of leno fabric is enrolled with the invention of lace fabric. Morton Groundng and Borland Ltd was the invented the lace fabric. Morton Groundng and Borland Limited was founded in 1900 in the Irvine Valley of Ayrsire, Scotland. Leno weave is the general term applied to all classes of weaves of a peculiar structure in which some of the warp ends do not lie parallel with, but are twisted partly around, other ends. This principle of interweaving is called leno weaving or gauze weaving. In this weaving one portion of the

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warp threads twisted partly or wholly round other warp threads. The close shedding is very suitable for this purpose (Banejee, 1993). When looking at a leno fabric, one might think that the yarn were twisted fully around each other, but that is not true. Careful examination shows that they are crossed and that one yarn of the pair is always above other (Sara, 2006). The leno weave is used where relatively low numbers of yarns are involved. The leno weave locks the yarns in place by crossing two or more warp threads over each other and interlacing with one or more filling threads. A plain, or pure, gauze fabric, as represented in Fig. 1, is one in which an end of the warp is raised on one side of an adjacent end on one pick and raised on the other side of the same end.

![Leno fabric](image)

**Fig. 1.** Leno fabric

Leno fabric produces all over the world within particular countries such as China for limited uses. But present days the areas of textile technology extend gloriously. Textile technology enrolls with the civil engineering and construction field constantly. Leno fabric is technical term in textile engineering and its application area is also increased. Crossing of warp yarn with weft yarn of leno fabric, the warp-weft cohesiveness is higher than the plain fabric which is more compatible for geo-textile. For this reason leno fabric is extreme tear and bursting resistant. In this sense the author’s effort to increase field spectrum of leno fabric and attempted for further production of leno fabric (for jute yarn) in South-Asia (especially Bangladesh) by modification of hand loom without dobby shedding mechanism.

**Materials and Methods**

**Materials:** The materials used in this project are mentioned below: 1) Ordinary hand loom, 2) Jute yarn, 3) Harnesses, 4) Slackener mechanism, 5) Coarser reed count frame and 6) Nylon ropes.

**Method:** In this project, the authors analyzed the structure and production procedures how leno fabric is produced. The authors also analyzed how to apply these procedures into hand loom. According to this project, the methodologies for leno fabric are mentioned below.
Harnesses arrangement: To produce leno fabric, four harnesses and special mechanism are necessary to control the warp yarn. Two of the harnesses are of the usual type. The other harnesses are of peculiar construction and called the standard and the doup harness. The standard harness is shown in Fig. 2 which is like an ordinary harness with the exception that each heddle has two eyes instead of one.

![Fig. 2. Standard harness](image)

In order to provide for crossing the doup and ground ends in weaving, it is necessary to combine the doup and the standard harness in the manner shown in Fig. 3. In attaching the doup harness to the standard harness one end of the doup is fastened to a cord stretched tightly across the lower part of the doup-harness frame; the other end is passed around the heddle bar, through one eye of the standard heddle, back through the other eye, and after being passed around the heddle bar again, is fastened to the cord beside the first end (Patterns weaving monogram, 2002).

![Fig. 3. Doup harness with Standard harness](image)

The four harnesses are arranged in the following order, beginning at the front: doup harness, standard harness (through the heddle of which the doups pass), ground harness, and back harness. The ground and the back harnesses are usually placed as far back as possible, so as to put the least possible strain on the doup ends when the crossing takes place. Fig. 4 shows the arrangement of the harnesses and the method of drawing in the
doup and ground ends. The doup end is first drawn over the slackener rod and through the back harness and doup, as shown in Fig. 4. Although this end is usually called the doup end, it is also called the douping end. The ground end is drawn in the usual manner over the whip roll and through the ground harness, but is then crossed over the doup end; it is then drawn in the same dent in the reed as the doupend.

**Fig. 4.** Arrangement of harnesses

**Slackener mechanism:** The normal position of the doup end is on one side of the ground end. But on every alternate pick it is crossed under the ground end and raised on the opposite side. Whenever this crossing takes place, an additional strain would be brought on the doup ends if some arrangement were not provided to compensate for the extra length of warp yarn required by the crossing action of the doup ends. To obviate this difficulty a mechanism, called the slackener show in Fig. 5.

**Fig. 5.** Slackener mechanism

**Operation of harnesses:** It is mentioned that cross effect completes within two picks. On the first pick, the doup end is raised on the left of the ground end and passes straight from the back harness to the fell of the cloth, as shown in Fig. 6. On this pick the ground harness remains down, as does also the standard harness; the back harness is raised, in order to lift the doup end, and the doup harness must also be lifted, so that the doup end
in rising may pull the doup through the eyes of the standard heddle. Hence a shed form and first pick is done.

Fig. 6. Position of harnesses in 1st pick

On the second pick the doup end is raised on the right of the ground end, which it crosses in forming the shed, as shown in Fig. 7. The doup end is raised on this pick by lifting both the doup and standard harnesses, which act as one. As the ground harness is down, the back harness must also be down to avoid straining the doup end, since the doup end crosses the ground end directly in front of the ground harness. It is evident that when this crossing of the ends takes place and the shed is formed wholly in front of the ground harness, there is considerable strain on the doup end.

Fig. 7. Position of harnesses in 2nd pick

Warp beam: When there use one warp beam, the direction of crossing can affect locking, especially with smooth monofilament yarns. When using two beams it is also possible to use different types and counts of yarn for standard and crossing ends for design or technical applications (Horrocks and Anand, 2000).
Modification of Hand Loom

Ordinary hand loom: In order to weaving the leno weave structure hand loom had to develop as the leno structure is different from the basic simple weave structure. We have changed and inaugurated some extra arrangement of the basic mechanisms of a hand loom operations and motions. There are three main operations in a hand loom: Shedding, Picking and Beating. Some warp ends are raised and others are lowered according to a particular design to opening called a shed for insertion of a pick. This operation is called shedding. Then a weft thread is inserted one at a time in the space between the raised and lowered ends. This operation is called picking. The third operation is called beating up, consists of pushing a weft thread which is laid inside the shed against the preceding weft by means of a comb-like part (reed).

Changes in different parts of hand loom: There are followings changes takes place-

Harnesses: In an ordinary hand loom there are mainly two heald frames. But for producing leno fabric with ordinary hand loom it is needed two extra heald frames. The arrangement of harnesses/heald frames are mentioned below orderly: Back harness, Ground harness, Standard harness and Doup harness. Back and ground harnesses are regular types of heald frame. Standard harness is made of steel, wood, iron and nylon wires. It is previous said that, Standard harness contents double eye heald wire. These heald wires were collected from local market. There was made a steel frame by 1.5 inch spat shade in the local welding market and set the double eyes heald wire into the steel frame (Fig. 8).

There was made another steel frame in which the width of the rod is 0.5 inch for doup harness. Then these two harnesses united in a particular way. There made small pieces of tinny nylon rope with definite length that is called doup end. Then one edge of the doup end stretched tightly in bottom part of doup harness and the other end delivered through two eye of heald wire (Fig. 9). Then this end tightly stretched with the bottom part.
Fig. 9. The combination of standard and dauphinesses

**Slackener mechanism:** It is the most essential mechanism to weave the leno structure with any type of loom. The main function of the slackener is to control the movement of doup ends. The normal position of the doup end is on one side of the ground end. But on every alternate pick it is crossed under the ground end and raised on the opposite side. Whenever this crossing takes place, an additional strain would be brought on the doup ends if some arrangement were not provided to compensate for the extra length of warp yarn required by the crossing action of the doup ends. Here the slackener (Fig. 10) uses to give a little slack to the doup ends when they are raised out of their normal position. If there is no slack during weaving the desired twist will not imposed upon the fabric been produced.

Fig. 10. Slackener mechanism
**Warp beam:** In order to getting the desired leno structure authors had to change drawing mechanism. The authors separated the warp yarn into two sets (odd and even number) of same warp beam (Fig. 11). The odd number yarn is called doup end and even number yarn is called ground end. One of the two sets was drawn like as ordinary type and another was drawn over slackener roller.

![Fig. 11. Yarn separation of warp beam](image)

**Reed frame:** As authors used the jute yarn to weave the leno structure there needed a special type of reed frame (Fig. 12). Jute ends count no. is 18.1069/2, it means coarse end. As well as two ends are passed through the one dent of the frame. That’s why used a reed having the 20 count.

![Fig. 12. Reed frame](image)

**Harnesses arrangement and connection with paddles:** Authors used one extra paddle besides two paddles of original hand loom. There need this type extra paddle for...
movement of slackener roller and movement the combination of standard and doup harnesses. In this process, the ground harness is lowered 1st and 2nd Pick; there kept it lower position by dead weight. This extra paddle used in 2nd pick. In the theoretical chapter it is mentioned that in the first pick, the back and doup harnesses raise and the ground and standard harnesses remain lower. In the 2nd pick the doup and standard harnesses remain raised and back and ground harnesses remain lower. From this view, there connected between the back and standard harnesses by two and three number paddle. The slackener roller joined to one number paddle. Doup harness joined together with paddle number one and two and also attached dead weight, so that it can rise in every pick. The connection of the harness with the paddles are shown below-

![Diagram](https://example.com/diagram.png)

**Fig. 13.** Connection of harnesses with paddles

Cross of doup and ground end: To make leno fabric there need two sets yarn whose are doup and ground yarn. At the first doup yarn was drawn into back harness. Then ground yarn was drawn into the ground harness. The ground yarn goes cross over the doup yarn pass into standard harness. Then the doup yarn goes cross down the ground harness. Then the doup yarn passes into loop of doup harness. Then doup yarn and ground together with drawn same dent of reed frame.

![Image](https://example.com/image.png)

**Fig. 14.** Cross of doup and ground end
Pick and beat-up action: In the first pick, paddle three down, hence the back harness rise up and simultaneously standard harness down. As ground harness remains down by dead weight and doup harness connect to the paddle three, it rises up; hence produced shed and 1st pick is done. In the 2nd pick, down the paddle number one and paddle number two. The standard harness rise up and back harness down (Fig. 15). Due to down up the paddle number one, the slackener down to give up maximum stretch of doup yarn and doup harness connect to paddle number one, also its rise up. The back and ground harness remain down. Due to the maximum stretch, doup yarn raise across ground yarn, form a shed, 2nd pick is done.

![Fig. 15. Order of harnesses for 1st and 2nd picks](image)

Finally authors produced the following leno fabric-

![Fig. 16. Leno fabric](image)
Applications of Leno Fabric

The surface of leno fabric is like net or perforated. So surface is rough. Normally repeat size is even number. Smallest repeat size is 6x6. It has the property of water absorbency, so it can be used as towel \(^4\). Leno fabrics are extremely tear-resistant, of high-quality, easy to process and applicable in many different areas. It has a good form stability and solid mechanical strength. The technical properties of the fabric are carried over to the respective end product by combining it with other materials (e.g. by means of needling, coating and laminating) \(^6\). Due valuable properties of this fabric, the application field is increasing day by day.

Leno fabric as filter fabric and others purpose: Since the Leno fabric has open porous structure; it can be used as fiber fabric. Filter fabric screens out soil while allowing the passage of water. It is also called engineering fabrics. Filter fabrics are used in a large number of industrial sifting or filtration applications. The main properties of Filter fabric is to stability, which is passed by leno weave. In the comparative with the plain structure it is not more stable than leno weaves for Filter fabric. Because there is intend to displacement of warp and weft yarn in plain fabric, but in leno fabric there is lower intend \(^7\). Fabric made by leno weave marquisette, mosquito netting, agro-textiles to shade delicate plants. Polyester marquisettes are widely used for sheer curtains. Casement draperies are frequently made with leno weave and novelty yarns. Thermal blankets are sometimes made of leno.

![Fig. 17. Leno fabric as marquisette](image_url)

Leno fabric for soil erosion control: Leno fabric is special type geo textile which used in soil erosion control in slope of hill tracks, road, embankment etc. It is used in reforesting of damaged area of hill tracks. During the rainy season, the flow of rainwater takes away the soil particles from the surface of the earth thereby causing soil erosion. Erosion rates are highest on steep slopes, sites where protective vegetation has been removed or simply where the forces of rainfall and wind exceed the soil's resistance to detachment and movement away. Geo-textiles can prevent soil erosion by protecting the soil particles. Since jute geo textiles are biodegradable, their effective lifespan for erosion control can...
be limited or designed. The geo textiles degrade with time and do not prevent vegetative growth. In fact, they facilitate vegetation that ultimately becomes the permanent erosion control and slope protection medium. So, jute geo textiles help in preventing landslides, reducing soil erosion and increasing fertility of soil (Som N, 2010).

Fig. 18. Soil erosion control and erosion control of rivers, lakes

Reforesting of hill tracks, roads, and embankment: Jute geo textile is used for reforesting. In this following figures, there use jute geo-textile which structure is plain weave. But leno fabric is very special for reforesting. Leno fabric is specially used in difficult access of place, seed bind with leno fabric, and then the fabric spreads over the damaged place. After passing some time, jute fiber start to dispose and it supplies nutrients for seed planting.

Fig. 19. Reforesting of hill tracks

Leno fabric for reinforcement: This is the synergistic improvement in the total system strength created by the introduction of a geo textile into a soil and developed primarily through the following three mechanisms: Lateral restraint through interfacial friction
between geo textile and soil/aggregate; Forcing the potential bearing surface failure plane to develop at alternate higher shear strength surface; In this method, the structural stability of the soil is greatly improved by the tensile strength of the geo synthetic material. This concept is similar to that of reinforcing concrete with steel. Since concrete is weak in tension, reinforcing steel is used to strengthen it.

![Fig. 20. Reinforcement for roads construction](image)

Leno Fabric as Bags: Leno fabric has stable open porous structure. Hence it cannot fade easily. Due to the property of this type of fabric, leno weave is popular in market as bags. Leno fabric is used in market as fashionable bags for women, selling bags for potato, onion, ginger and others goods. Leno Bags, also use Leno Mesh Bags, can be widely used for packing of various Agricultural products such as: Onion, Garlic, Potato, Carrot, Ginger, Orange, Pineapple etc. It is also popularly known as mesh bags.

![Fig. 21. Leno fabric use as a bag](image)
Result and Discussion

The authors determined some physical properties (grams per square meter, tensile strength and bursting strength) of this fabric. The grams per square meter, tensile strength and bursting strength are 305.34 gm/m², 385.0716 N and 316.984 Kpa. It earlier said that the bursting strength of this fabric is extreme higher due to crossing. In the following test, this fabric gratified the bursting strength at low grams per square meter. Hence forward authors think that leno fabric is to be used for different fields vigorously.

Conclusion

Leno fabric is a technical term in textile engineering. Leno fabric produces in modern dobby shedding loom. Absent of dobby shedding, magnificently authors produced the desired the leno fabric (jute yarn) by modification of hand loom. Although there was some problems arise during the production of this fabric in modified hand loom, authors think that further modification will help for smooth production. About all jute fibers grow in this region and normally used it for various purposes. In Bangladesh jute fibers use as jute geo textiles in different fields as ordinary plain weave. Leno weave fabric produced from jute will be highly benefitted more than ordinary plain weave.

References

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