Lesson 7  Weaving, Basic Weaves and Standard Fabrics

Structure

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7. **Weaving, Basic Weaves and Standard Fabrics**

This first course of the programme aims to provide you with a bird’s eye view of textiles. Fibres, being the smallest basic unit of any textile product, formed the subject matter of the first unit. The second unit dealt with yarns, which are strands of fibres. The yarns are then interlaced together to form a fabric. This process is known as weaving. Fabrics can also be constructed by knitting or by making a non-woven Fabric. All these fabric types will be covered in this unit. The present lesson deals with weaving and woven fabrics.

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7.0 **Objectives**

After going through this lesson, you will be able to gain an understanding of:

- The process of weaving
- The basic mechanism of weaving on the loom.
- A loom, its different parts and its primary and secondary motions involved in weaving process.
- The basic weaves, the different fabric structures produced and their characteristics.
- The wide variety of standard fabrics, particularly those available in India.

7.1 **Introduction**

Most textile fabrics are made from yarns (some fabrics made directly from fibres are described in Lesson 9). Yarns, as described earlier, are made by grouping together of staple fibres or of continuous filaments, usually by twisting them around their length to impart cohesion.

There are different routes for making fabrics but the most well known fabric form is that of the woven fabric which is made by interlacement of the warp yarn with the weft yarn at right angles to one-another. The warp threads lie along the length of the fabric (also called ends) while the weft threads (also called picks) run across the fabric, *i.e.* along its width. The process of interlacing (weaving) and the basic types of interlacement (basic weaves) will be described in this lesson.

Knitted fabrics represent the second important class of fabrics - they are formed by interlocking loops of yarns either in the weft or in the warp direction. These will be discussed in the next lesson.
A third category of fabrics (already referred to earlier) is that of non-woven fabrics which are neither woven nor knitted but in which the fibres are made to felt or mat together, often without any organized order. In addition to non-woven fabrics, small quantities of net fabrics, laces and braids are also made. We will learn about all these in Lesson 9.

This lesson will also give a brief description of some more common standard fabrics based on the three basic weaves described in section 7.3. Most of the fabrics described are based on cotton but in some cases they may be based on blends (cotton-polyester blend, for example), or on other fibres like silk, wool or synthetic fibres.

7.2 Process of Interlacement or Weaving

7.2.1 Introductory remarks

The mechanical process of interlacement of the warp with the weft is usually carried out on a loom. In this lesson we will begin with a discussion of the process of weaving which will also include a description of the various parts of a loom and their functions. This is a fairly extensive and complex topic and only a brief outline will be presented. This will be followed by a description of the basic weaves that can be created on a loom.

Before taking up weaving, it is worthwhile giving some statistics on cloth production in India. In 2000-01, India produced more than 400 crore square metres of fabric. Out of this, 63% was produced by the power loom sector, 14% by the hand loom sector, 19% by the hosiery sector and 4% by the organized mill sector. It is in the organized mill sector that the more sophisticated looms like the shuttleless looms are used but they produce only a very small fraction of the total fabric produced.

So far as the main functional parts of the handloom and power loom are concerned, there is considerable similarity between the two. While discussing the process of weaving, we will describe the loom and try to understand how the various parts of the loom contribute to continuous fabric production.

7.2.2 The process of weaving

A woven fabric is produced on a machine called a loom. The starting point for making a fabric is to get the warp beam (which is a sheet-like assembly of parallel yarns wound on a roll) ready for transfer to the loom. Though the various parts of a loom and their functions will be described later, a schematic sketch of the loom with the warp beam located at the backside of the loom is shown in Fig. 7.1 for the sake of clarity. The path of the warp sheet on the loom is worth noting. The actual yarn interlacement goes on in the front part of the loom and the woven cloth is then wound on the cloth roll. At this stage it would be instructive to understand how the warp beam is filled with yarn. To do this the dimensions of the cloth to be made must be known. Suppose 400 metres long cloth with 2400 threads width-wise is to be produced. Also suppose that the creel stand, which is installed for making the warp beam, has provision for mounting 200 bobbins at a time. So the warp will be made by winding 200 yarns (of 400 metre length) in the
form of a sheet on the warp beam. Note that the process will have to be repeated 12 times to complete the warp beam.

After working out the details about the warp beam as given above, the empty warp bobbins are filled with the warp yarns using a winding machine. The filled bobbins are then mounted on the creel stand. Individual yarns from each bobbin are taken out and led collectively towards the warp beam in the form of a planar sheet and a 400 metre long, 200 yarn wide section of the warp wound on a part of the beam. By repeating this 12 times, the warp beam is completely filled and is ready for transfer to the loom. Before doing this, the normal industrial practice is to apply size to the warp yarns to impart cohesion to the yarns so that they run smoothly during production.

The ensuing operations are best explained with the help of a line diagram showing a section of the open warp in a handloom machine. In Fig. 7.2 (taken from suggested reading no. 1) the various parts of the loom have been listed. The weaving process will now be described with the help of Figs. 7.1 and 7.2.

To begin with, the filled warp beam is transferred to position F (Fig. 7.2) and the warp is taken over the back rest (G) and alternately over and under the

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**Fig. 7.1 Process of Interlacement or weaving**

**Fig. 7.2 line diagram of an open warp**

A. Treadle (Pedal)    D. Heald    G. Back Rest    J. Reed    M. Cloth beam
B. Treadle (Pedal)    E. Heald    H. Lease Rod    K. Cloth Fell    N. Fulcrum
C. Top Pulley        F. Warp beam    I. Lease Rod    L. Front Rest    O. Shed
lease rods H and L, through the eyes of the _healds_ (also called heddles) D & E. The healds are mounted in a heald frame (also called _harness_). The warp yarns are then guided through the dents of the reed J (which is like a comb) to the fell of the cloth, K (which is up to the last pick or weft in the cloth which has been put in place by the reed). Then the warp is taken over the front rest L (Fig. 7.2) onto the cloth beam M. The pedals A and B (also called _treadles_)  *fulcrumed* at O, govern the up and down movement of the healds to form an opening by splitting the warp into two layers, one going up and the other down, through which the weft yarn can be inserted. When pedal A is pressed down, the heald D connected with it by cord, forms the lower layer of the opening and causes the heald E to form the upper layer, thus creating what is known as a shed with the help of the top pulley C.

After insertion of the weft thread (called a pick), the shed is closed and a second shed is formed for the second pick to be inserted by pressing down the treadle B. By alternately pressing down the two treadles A and B, a plain weave (described later) is produced.

The large number of healds, which are made either from cords or from metallic strips, are held in a frame and the total assembly (including the heald shafts) is called harness. For different weave types, the number of harnesses varies considerably, the minimum number being 2 for plain weave but can go to a much larger number (a maximum of 40 harnesses is mentioned in the literature).

Fabric manufacture involves three primary and two secondary motions.

*The primary motions are:*

i) _Shedding_: This is the process of splitting the warp sheet into two parts, with the help of heald shafts. Each shaft is provided with a group of healds. Each heald consists of a metallic wire provided with an eye (heald eye) through which a warp yarn is drawn. As per the weaving design repeat, we know how to draw the warp yarns in two, three or five heald shafts, subject to the lifting plan. With the movement of heald shaft, the warp yarns attached to each shaft will also have up and down movement, thereby dividing the warp sheet into two layers. The opening so formed is a shed.

ii) _Picking_: This is a process of laying the weft yarn across with the help of a shuttle inside the shed.

iii) _Beating_: In this process, a comb (known as Reed) carries the weft yarn, drawn in the shed and places it along with the last weft, also known as the ‘fell of the cloth’. The reed is fitted in a frame — the assembly is known as a sley, sometimes also referred to as a batten.

*The secondary motions are:*

iv) _Let off_: This is a release mechanism attached to the weaver’s beam, which operates and controls the release of warp yarn from the beam.

v) _Take up_: A chain of wheels regulates the picking up of the cloth and keeps wrapping up the same on a cloth roll, through a roll, known as Emery Roll.
Self-check Questions

1. Name three principal methods of fabric construction.

2. List six important parts of a loom.

3. Fill in the blanks:
   i) The primary motions ________, _______ and _______ are involved in fabric manufacture.
   ii) Warp threads lie along the _________ of the fabric, while weft threads lie along its _______.
   iii) A fabric is woven on a _______.
   iv) The warp threads are also known as ________, while the weft threads are also called ________.

Activity

1. Observe a handloom present in your textile lab; i) Illustrate it on ivory sheet labeling its different parts. ii) Try to learn the steps involved in threading and operating processes.

7.3 Basic Weaves

During weaving the warp and the weft can be interlaced in a wide variety of ways to give different weave types. A weave may be characterized by its repeat unit. Basic weaves are those that require a minimum number of warp and weft yarns to constitute their repeat units, e.g., plain weave needs just 2 warp and 2 weft yarns. Twill weave needs 3 warp and 3 weft yarns while satin weave needs a minimum of 5 warp and 5 weft yarns. A large number of weaves can be derived from these three primary or basic weaves - the latter will be considered in some detail now.

7.3.1 Plain weave

Plain weave is the simplest form of interlacing (Fig. 7.3) and can be generated with only two harnesses. One harness controls the movement of even numbered yarns in the warp sheet and the other harness controls the movement of odd-numbered yarns. To begin with, the first harness lifts up the even-numbered yarns and the shuttle moves to insert a weft yarn. While returning, the second harness lifts up the odd-numbered yarns and the shuttle then moves below it to insert another weft yarn. Thus in plain weave the sequence of interlacement is altered for every adjacent end and thus the structure produced looks alike on the face and back of the fabric. A schematic representation of the plain weave structure is shown in Fig. 7.3.
Such structures may also be shown graphically as in Fig. 7.4. In this figure the longitudinal columns are considered as warp/ends and numbered as 1, 2, 3, 4. In the same way the transverse rows are considered as weft/picks and also marked as 1, 2, 3, 4. The convention is that where the warp yarn goes up over the weft, it is marked as a black square and where the warp yarn is below the weft yarn, it is left blank (white square).

For representing “plain” weave, warp No. 1 goes above pick No. 1, so marked black, below pick No. 2, so left blank, above pick No. 3, marked black and below pick No. 4, left blank and so on.

Now warp/end 2, which is to reverse this sequence, starts interlacing from pick No. 2. It goes above pick No. 2 so marked black, below pick No. 3, so left blank, above pick No. 4, so marked black, and this continues.

In this graph, the interlacement of warp and weft represented on 2 warp ends and 2 weft picks, goes on repeatedly to form the fabric structure. This plain weave structure is very compact and perhaps the most used woven structure.

7.3.2 Twill weave

The twill weave structure requires a minimum of 3 warp/ends and 3 weft/picks to produce this weave which is distinguished by diagonal lines, as shown in Fig. 7.5.

The simplest twill is that created by the weft crossing over two warp yarns, then under one, the sequence being repeated in each succeeding shot (pick), but stepped over, one warp either to the left or to the right. Twills with more warps than wefts floating on the fabric’s face are called warp faced; those with wefts predominating, are called weft faced.

Here the interlacement of warp and weft is only possible in two ways as shown below – i) 2 up 1 down ii) 1 up 2 down.

The above procedures generate (1) right hand twills which may be 2 up 1 down (Fig. 7.6) or 1 up 2 down (Fig. 7.7) or (2) left hand twills which may be 2 up 1 down (Fig. 7.8) and 1 up 2 down (Fig. 7.9) twills.
From the figures it is very clear that the twill repeat is completed in 3 warp and 3 weft yarns. After the interlacement, the fabric shows diagonal lines running at 45 degree.

In Figs. 7.6 & 7.7, these lines run from lower left to upper right - this ‘twill’ is known as ‘right hand twill’. And if these diagonal lines run from lower right to upper left (Fig. 7.8 and 7.9), then it is called ‘left hand twill’.

![Fig. 7.8 Left Hand Twill](image)

In both the above two weaves, i.e., plain and twill, the next corresponding adjacent warp yarn starts interlacing by stepping up by one square in the graph. This stepping up of square is called the ‘stepping number.’

### 7.3.3 Satin/Sateen weave

Satin is a cloth that typically has a glossy surface and a dull back. A satin is a warp-dominated weaving technique that forms a minimum number of interlacings in a fabric, as shown in Fig. 7.10.

![Fig. 7.10 Sateen Weave](image)
A satin-woven fabric tends to have a high lustre due to the large number of "floats" on the fabric. Floats are "missed" interlacings, where, the warp yarn lays on top of the weft yarn, or vice versa. The floats tend to make the fabric look glossier as well as give it a smoother hand in most cases.

This type of weave requires a minimum set of 5 warps and 5 wefts.

While weaving, the following three basic principles have to be followed.

i) The numerical pairs should be so selected that the total should be equal to the number of shafts on which the satin weave will be produced. For example, for 8-end satin, you need 8 shafts. So the pairs will be 1 & 7, 2 & 6, 3 & 5, 4 & 4.

ii) The stepping number cannot be 1 or less than 1 of the total number of shafts i.e. 8-1 = 7 (in this case) and

iii) The numerical pair values should not be a factor of the total number of shafts i.e. the stepping number cannot be 2, 4 and 6.

A satin/sateen weave on eight shafts can only be produced in two ways i.e. when the stepping number is either 3 (Fig. 7.11) or 5 (Fig. 7.12).
Similarly, if a satin/sateen weave is to be prepared on 5 warps and 5 picks, then the stepping numbers can only be 2 or 3, on the basis of the above three principles. Such 5 end fabrics are shown below in Fig. 7.13 and Fig. 7.14.

Weft-face Satin is called SATEEN and Warp-face Satin is called SATIN but in the market, where weft-face satin weave is mostly used, it is loosely called Satin Weave/fabric.

![Weave Structures](image)

**Self-check Questions**

4. Fill in the blanks:

i) The simplest form of interlacing is ________ weave.

ii) Twill weave requires a minimum of _____ warp and weft threads each.

iii) ________ fabric has a glossy surface and a dull back.

iv) Two types of twill weaves are __________ twill and __________ twill.

v) Plain weave requires ________ harnesses for construction.

**Activity**

2. Try to plot the weave structure on a graph paper (8 x 8) after analyzing the 5 different weave fabrics with the help of a Pick Glass.
7.4 Some Standard Fabrics

A very wide range of fabrics is produced in India to cater to its very diverse cultural heritage in which the traditional and modern dresses co-exist. The variation in textiles in use in different parts of the country would perhaps be unmatched in the world. The variations are achieved by modifying the basic weaves, by using fancy yarns, coloured yarns, reverse twist yarns and using a variety of ornamentation techniques like dyeing, printing and embroidery.

7.4.1 Plain-weave fabrics

Some of the plain woven fabrics are available in the market under the following names.

- Sheeting
- Lawn
- Muslin
- Poplin
- Canvas
- Casement
- Organdy
- Cambric
- Chambray
- Gingham
- Voile
- Georgette
- Chiffon
- Rubia

All these fabrics are different from each other because of variations in thickness, colour or twist of yarn in warp and weft of both. The plain weaves that we are going to touch upon today are mostly in cotton.

- **Sheeting** is medium to heavy weight plain weave fabric. It is mostly used for upholstery, bed covers etc. Fine sheetings are woven with cotton-polyester blended yarns.

- **Lawn** is a light, thin fabric, made slightly stiff and crease-resistant by finishing. It is used in making dresses, blouses and handkerchiefs. It has typically 30 × 32 ends/picks per cm.

- **Muslin** is light weight to medium weight stiff, unbleached and unfinished plain woven cloth. It is used in making designer sample garments. Finished muslins are used in sheets, furnishing etc. Besides cotton, they may be made of silk and worsted yarns also.

- **Poplin** is a medium plain weave fabric having finer warp and thick weft. Its main characteristic is that it looks like having rib effect in the weft direction. A considerable amount of mercerized cotton goes in making poplins. All poplins are finished and calendared (pressed). It is used in making petticoats, pyjamas, blouses etc. Typically the number of ends and picks is 48/24 per cm.
- **Canvas** is a heavy weight densely woven plain grey (unfinished) fabric. It is used in making working cloth, jump suits and industrial clothes. Besides cotton, hemp and jute fibres are also used. Ends/picks: 10-20/10-16 per cm.

- **Casement** is a plain weave cloth with lesser twist in warp and weft. It is used in making furnishing, embroidery work, table linen etc. Ends/picks 21 × 25 per cm.

- **Organdie** is a light weight, crisp, sheer, shining white cotton fabric, which is produced by using fine (thin) warp and weft yarn. It is given a special chemical finish. It is used in making dress materials.

- **Cambric** is a soft, smooth closely woven (compact) fabric, which is given a finish on the upper surface of the fabric to give a glazed (shining) effect. It is used in making dress materials, children’s dresses, table linen etc. Typically it has 38 ends/cm. and 32 picks/cm.

- **Chambray** is a plain, medium to heavy weight, woven fabric with coloured warp and white weft. It can be in plain, strips or check designs. It is used in making, work suits, overalls, men’s suits etc. (Denim comes under this, except for the weave).

- **Gingham** is a medium to light weight plain weave fabric of open texture having different coloured warps and wefts. They vary in qualities according to the yarn used, fastness of colour, weaves and weight. They are used for making house dresses, aprons, curtains etc.

- **Georgette** is a sheer light-weight fabric with double yarn, highly twisted in S and Z directions, in warp and weft. It gives a sand-like rough appearance on the surface of the fabric. It is used in making saris and women’s wears.

- **Voile** is sheer light-weight fabric, highly twisted, using double fine combed yarn in warp and weft. This gives a crisp body and good draping quality. It is used in making blouses, bedspreads, summer dresses, children’s wear etc. Besides cotton, voile is made from worsted also.

- **Rubia** highly twisted, using double fine yarn warp and weft fabric, plain textured (appearance) which gives a transparent look. It is used in making saris and blouses.

### 7.4.2 Twill Weave fabrics

A Twill weave has warp yarns as 2-ply and weft yarns as singe ply. Denim, Gabardine and Drill are twill-woven fabrics.

- **Drill** is a densely woven, medium weight durable fabric. The fabric is sized, calendared and mercerized to give a very compact dense look. This fabric is called khaki when dyed in khaki colour. Some clothes made of Drill include work shop clothes, sneakers, shorts, overalls etc.
• **Denims** are made from high twisted yarns. It is a densely woven fabric and has medium weight. It has coloured warp and plain white weft. It is made with indigo blue dyed warp and gray or unbleached weft. The warp floats on the face and weft floats on the back of the fabric. Denim is used for work clothes, jeans, slacks, beach robes, shirts etc. 36/24 ends and picks/cm.

• **Gaberdine** is a medium weight fabric made from fine yarn. It has a very pronounced warp faced twill weave. The fabric is made with carded or combed yarns and single or plied yarns are used in the weft. It is used in making uniforms, sports wear, raincoats, skirts etc.

### 7.4.3 Satin Weave Fabrics

Satin is medium or heavy weight fabric, made with fine closely woven warp yarns. It gives strong, soft and lustrous fabrics. It has smooth face and dull rougher back. The fabric is mercerized for a shining look. It is used in making wedding saris and dresses.

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**Activity**

3. Taking five common fabrics, examine them for their construction, fabric thickness, type of yarn used, handle, lustre, feel, etc. Submit a detailed report on these fabrics.

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**Self-check Questions**

5. What gives Denim its unique look?

6. Why are fabrics made with satin weave more lustrous?

7. List the fabrics that are most suitable for making ladies’ saris. State the reasons for your choice.

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**Assignments**

### 7.5.1 Class assignments

i) Draw the twill weave structure on graph paper.

### 7.5.2 Home assignments

i) Obtain pieces of fabrics that are plain woven, twill woven and satin/sateen woven. Cut them into square pieces, paste them on a chart and label them.
7.6 **Summing Up**

i) In this lesson, we started with a consideration of the process of weaving and the loom and its various parts were described and discussed. The various types of weaves that can be produced on the loom were then described. Some standard fabrics based on the three basic weaves (plain, twill and satin) which are available in the Indian market, are also described here. and it was concluded that :

ii) There are three types of basic weaves: Plain, twill and satin.

iii) These are also called the prime weaves.

iv) Plain weave requires a set of two warp yarns and two weft yarns to form a repeat unit.

v) Twill weave requires a set of three warp yarns and three weft yarns to form a repeat unit.

vi) Satin weave requires a set of five warp yarns and five weft yarns to form a repeat unit.

vii) The fabrics differ in various respects, viz., their look, compactness, lustre, thickness, feel, handle, aesthetics, mechanical and other properties, etc. These differences are brought about by using yarns with different dimensions, twist levels, using different fibre types, etc., by weaving fabrics with different compactness, etc.

7.7 **Possible Answers to Self-check Questions**

1. Weaving, Knitting and Non woven techniques.

2. Warp beam, Harness, Heddles, Reed, Shuttle, Cloth beam.

3. Fill in the blanks:
   i) Shedding, Picking, Beating.
   ii) Length, Width
   iii) Loom
   iv) ends, picks

4. Fill in the blanks:
   i) Plain
   ii) Three
   iii) Satin
   iv) left hand twill, Right hand twill
   v) two

5. Denims are made from high twisted yarns. It is a densely woven fabric and has medium weight. It has coloured warp and plain white weft. It is made with indigo blue dyed warp and gray or unbleached weft. The warp floats on the face and weft floats on the back of the fabric, which gives it a unique look.
6. Satin is medium or heavy weight fabric, made with fine closely woven warp yarns. It is a warp-dominated fabric with minimum number of interlacings. The fabrics used are generally mercerized. These factors make it lustrous.

7. The following fabrics, which are light in weight and aesthetically pleasing are suitable for saris:

- Silk
- Satin
- Georgette
- Chiffon
- Organdie

7.8 Terminal Questions

1. What is a loom? How is the warp beam prepared and drafted on the loom?

2. What are the primary motions and secondary motions of a loom? Explain why they are called so.

3. What do you understand by Basic Weaves? Name the Basic Weaves.

4. What are the features of Plain Weave and Twill Weave Fabrics?

5. What is a Sateen Weave?

6. Plain weave can give fabrics as different as muslin and georgette. How is this achieved?

7. Which type of weave has the highest interlacement density? How does this affect fabric behaviour?

7.9 References and Suggested Further Reading


7.10 Glossary
1. Cohesion  act of sticking together
2. Dimension  size
3. Warp Yarn  Yarn that lies along the length of the fabric.
4. Weft Yarn  Yarn that lies along the width of the fabric.
5. Glossy-  Smooth and shining
6. Plain weave  The simplest form of interlacing that can be generated with only two harnesses. The first harness lifts up the even-numbered yarns and the shuttle moves to insert a weft yarn. While returning, the second harness lifts up the odd-numbered yarns and the shuttle then moves below it to insert another weft yarn.
7. Beating  The final primary motion of the loom by which the inserted weft yarn is placed alongside the last weft yarn.
8. Cloth beam  The beam on which the woven cloth is wound on the loom.