6.1 Plain

The simplest interlacing pattern for warp and weft threads is over one and under one as shown in Fig. 10. The weave design resulting from this interlacement pattern is termed as plain or 1 / 1 weave. The 1 / 1 interlacement of yarns develops more crimp and fabric produced has a tighter structure. The plain weave is produced using only two heald frames. The variations of plain weave include warp rib, weft rib and matt or basket weave.

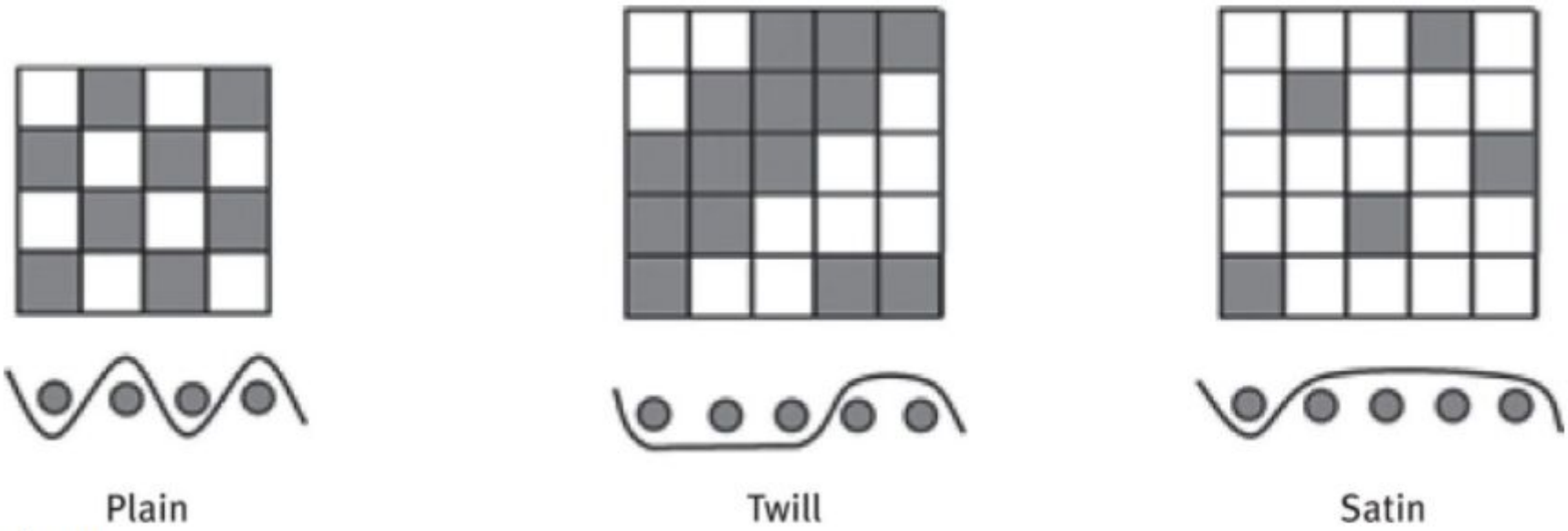

Fig. 10

6.2 Twill

This weave is characterized by diagonal ribs (twill line) across the fabric. It is produced in a stepwise progression of the warp yarn interlacing pattern. The interlacement pattern of each warp starts on the next filling yarn progressively. The two sub categories based on the orientation of twill line are Z- and S-twill or right hand and left hand twill, respectively. Some of the variations of twill weave include pointed, skip, and herringbone twill [11].

6.3 Satin / Sateen

The satin / sateen weave is characterized by longer floats of one yarn over several others. The satin weave is warp faced while sateen is a weft faced weave. A move number is used to determine the layout in a weave repeat of satin, and number of interlacements is kept to a minimum as shown in Fig. 10. The fabrics produced in satin weave are more lustrous as compared to corresponding weaves.

7 Specialty Weaving

There are certain specialty weaving techniques used for the production of a specific fabric type, for example circular loom, terry towel loom, denim fabric, narrow loom, multi-phase loom, 3D weaving loom, carpet / rug weaving, etc. The weaving is also used for the production of certain industrial fabrics and technical textiles [2] like conveyor belt fabrics, air bag fabrics, cord fabrics, geotextiles, ballistic protection, tarpaulins, etc. The denim fabrics are woven with a coarse count, high thread density and 3 / 1 twill weave. Dyeing is an additional process involved in the warp preparation for these fabrics [12]. The warp yarn of these fabrics is dyed with indigo dyes in such a way that only surface is dyed and core remains white. The

The towels are piled fabrics produced from two different set of warp; one serving as the ground and the other as pile. More length of pile warp is consumed as compared to ground warp. Therefore, two beams are required to produce such fabrics and need additional attachments on loom. In multiphase loom, several weft yarns are inserted simultaneously across the series of sheds. These shed are arranged sequentially in the warp direction. The 3D loom produces a 3 dimensional fabric on the required shape [13]. The carpet weaving involves a loom with two beam arrangement as in case on terry towel fabrics. The ground warp let-off, pile warp let-off and cloth take-up is controlled by servomotors [14]. It allows easy change of pile height and pick density. The tension in the pile warp sheet is controlled by a pneumatic beam brake.

13.2 Technical Face and Back

If the feet of the new loop cross under the legs of the old loop and legs cross over the head of the old loop, then this side is technical face or it may be defined as the side having all the face of the knit loop. Fig. 19 illustrates the interloping of the old and new loops, forming technical face side. If the feet of the new loop cross over the legs of the old loop and new loop legs pass under the head of old loop then it is said to be a technical back side. The interloping pattern of technical back is given in Fig. 19.

13.4 Stitch Density

The number of loops or stitch per unit area is called stitch density. This can be calculated by the product of course and wales density. In one inch square area of fabric, there are 6 loops or stitches as displayed in Fig. 20.

Stitch density of a knitted fabric is expressed as wales density and courses density. The number of wales per unit length is called the wales density, normally measured in wale / inch or wale / cm. In Fig. 20, there are three wales in one inch of fabric.

The number of courses per unit length is called the course density, normally measured in wale / inch or wale / cm. There are two complete courses in one inch of the fabric as shown in Fig. 20.

13.5 Stitch Length

The stitch length is the most important part of knitting. It is basically the length of yarn consumed to make one complete loop [16]. The knitted fabric dimensional, physical and mechanical properties are truly based on the stitch length that can be engineered to meet the requirement of the fabric. The individual loop is

14 Warp Knitting

Warp knitting may be defined as the loop formation process along the warp direction of the fabric [18]. The simultaneous sheet of the yarn is provided to the machine along the warp direction for the loop formation process. The sheets of yarn are supplied from warp beam as in weaving. Each warp end is provided to each individual needle. The same yarn runs along the warp direction and the needle draws the new loop yarn through the old loop that was formed by another yarn in the previous knitting cycle. Each yarn also passes through the guide mounted on guide bar that provides the movement of the same yarn between the needles.

The warp knitting machines are flat and fabric formation technique is more complex as compared to weft knitting. The flow process is given in Fig. 21. The comparison of warp and weft knitting is given in Table 2.

Comparison of warp and weft knitting [19].

Sr. #	Weft Knitting
1	Individual yarn is provided to feeder. If a machine has 90 feeders and all are active, then 90 courses are inserted in a c
2	Loop formation along the weft or course direction of the fabric.
3	The yarn is supplied in the form of cones or cheese. The number of cones required will be equal to the number of fee
4	The spun yarns are mostly the raw materials for weft knitting so only waxing may require to avoid abrasion between t
5	The weft-knitted fabric has less dimensional stability so careful handling is required.
6	The weft-knitted fabric is more stretchable in both directions (warp and weft)
7	Latch needle is preferably used in weft-knitting machine.
8	The application of weft-knitted fabric is mostly apparel including both outer and inner garments.

15 Applications of Knitted Fabrics

The application area of knitted fabric is mainly classified into three major categories such as clothing which includes weft-knitted vests, sweaters, pullovers, stockings, sportswear, underwears, etc. The home and furnishing textile is the second major class comprises of warp-knitted curtains, terry towel and weft-knitted blankets, upholstery, etc. The knitted fabrics also have a huge applications range in technical textile. Both warp- and weft-knitted fabrics are used in medical textiles such as compression bandages. The automobile industry also has the consumption of warp-knitted fabric in the form of seat covers, roofing and filtration. Packaging materials and mosquitoe nets are also made with knitted fabric [20].

16 Nonwoven

During the nonwoven fabric production, the yarn manufacturing as well as yarn preparation processes (required in woven fabric) are eliminated. Due to this reason nonwoven fabrics are cheaper as compared to the conventional fabrics. The great advantage of nonwoven fabrics is the speed with which the final fabric is produced. All yarn preparation steps are eliminated, and the fabric production itself is faster than conventional methods. Not only the production rate is higher for nonwovens as shown in Table 4 [21], but the process is more automated, requiring less labor than even most modern knitting or weaving systems. The nonwoven process is also efficient in its use of energy.

Different definitions of nonwovens are available by different organizations. According to the ASTM D 1117 01, nonwovens can be defined as:

> "A textile structure produced by the bonding or interlocking of fibers, or both, accomplished by mechanical, chemical, thermal or solvent means and combinations thereof"

According to the standard ISO-9092:1988, the nonwovens are:

> "Manufactured sheet, web or batt of directionally or randomly orientated fibers, bonded by friction, and / or cohesion and / or adhesion, excluding paper and products which are woven, knitted, tufted, stitch-bonded incorporating binding yarns or filaments, or felted by wet-milling, whether or not additionally needled. The fibers may be of natural or man-made origin".

The Association of Nonwoven Fabrics Industry, USA (INDA) defines nonwovens as:

> "A sheet, web or batt of natural and / or man-made fibers or filaments, excluding paper, that have not been converted into yarn, and that are bonded to each other by any of several means.
>
> To distinguish wet-laid nonwovens from wet-laid paper materials the following differentiation is made. (a) More than 50 % by mass of its fibrous content is made-up of fibers with a length to diameter ratio greater than 300. Other types of fabrics can be classified as nonwoven if, (b) More that 30 % by mass of its fibrous content is made up of fibers with a length to diameter ratio greater than 600 and/or the density of the fabric is less than 0.4 g / cm^3.