Textile Science

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Weave Descriptors

Figure 26.1 shows a small section of a woven fabric in a weave diagram. A surface view is presented along with two cross-sectional views, one lengthwise and one crosswise. The cross-sectional views represent how the yarn positions appear when the fabric is viewed at its cut edge. They are not necessary when the fabric has a simple structure, but they become useful as the number of sets of yarns increases. The weave diagram in Figure 26.1 is labeled with many of the terms discussed in this section.

The terms *warp*, *filling*, and *bias* specify direction. The crosswise direction of woven fabrics is called the *filling* direction, and the lengthwise direction is called the *warp* direction. The yarns that transverse crosswise are filling yarns and those in the lengthwise direction are warp yarns. Other terms used for filling are weft, woof, and picks. Warp yarns may be referred to as ends. In this textbook, the warp yarns are depicted in black and the filling yarns in white. The *bias* direction is any direction other than lengthwise and crosswise. A bias is either a true bias, meaning a direction at a 45° angle to the lengthwise edge, or a garment bias, meaning a direction at any angle other than 45° to the lengthwise edge.

Usually, the lengthwise edge of a woven fabric has a *selvage* to ensure that the fabric edge will not tear when it is subjected to the stresses of the finishing and dyeing processes. It is usually $\frac{1}{4}$ to $\frac{1}{2}$ inches wide, is more closely woven (denser), and exists on both lengthwise edges of the fabric.

Woven fabrics have a *face* and *back*. The side called the face usually has the more attractive appearance and is the side viewed during use or wear, as with the outer surface of a garment. Some fabrics, such as plain-woven and leno, are structurally identical on the face and the back due to the interlacing pattern used. Others, such as warp-faced twills and satin, differ in appearance on the face and the back.

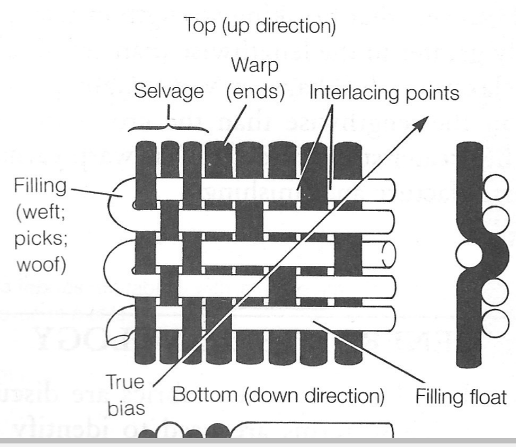
All fabrics have a *top* and a *bottom*. Usually these dimensions are not important because fabric appearance is the same regardless of which end is viewed. In other words, when a fabric is rotated 180°, its appearance is the same. However, pile woven fabrics—such as velvet, velveteen, and corduroy—exhibit different depths of color shade depending on the position in which they are viewed. This variation in appearance must be taken into account when fabricated products are made.

An *interlacing pattern* is a description of the *movement* of either the warp or the filling yarns from the surface to the back of the fabric and vice versa and of the manner in which adjacent yarns complete the movement relative to one another. The latter is called the *move number* or the *progression of interlacing* and is defined as "the number of filling yarns by which the interlacing of a warp yarn in a weave moves upwards relative to the warp yarn on its immediate left."

The weave diagram in Figure 26.1 is just sufficient to show one pattern or *weave repeat*, the smallest number of warp and filling yarns on which an interlacing pattern can be represented. In this case, five warp and five filling yarns are just sufficient (the three warp yarns in the salvage are excluded). The movement of each filling yarn is over four warp yarns and under one warp yarn. This pattern is best observed with the filling yarn at the bottom of the diagram. The movement of each warp yarn is under four filling yarns and over one filling yarn. This movement is most easily observed by viewing the first warp yarn at the left-hand edge of the body of the fabric. The progression of interlacing in the weave diagram is 2. To obtain this result, we first determine that the far right-hand warp yarn passes over the third filling yarn from the bottom. We then determine that the second warp yarn from the right passes over the fifth filling yarn from the bottom. Therefore, it is necessary to move up two filling yarns before reaching an identical interlacing point.

A *float* is "a length of yarn on the surface of a fabric between adjacent intersections. This corresponds to the number of yarns over or under which the intersecting yarn passes in a woven structure." In the weave diagram in Figure 26.1, the filling yarns form floats on the fabric face and the warp yarns form floats on the fabric back.

FIGURE 26.1 Structural elements of woven fabrics.



to achieve design in fabrics such as dobby and Jacquard. Snagging is a problem when the float is relatively long because the float yarn can be caught on broken fingernails or other rough surfaces. Floats weaken the fabric by reducing the frequency with which yarns pass from one side of the fabric to the other. They enable yarns to slide under each other in the fabric and are used to make fabrics with high fabric counts (many yarns per square inch).

Interlacing patterns determine the number of *interlacing points* in each square inch of fabric and the spacing of the interlacing points. The interlacing pattern has a significant influence on appearance and performance. Fabrics with fewer interlacings per unit area and more space between yarns usually are softer (and more supple) and drape better than fabrics with more interlacing and less space between yarns. When a fabric having a high number of interlacing points per unit area is pulled or torn, the warp and filling yarns dig into one another at their points of interlacing and the yarns are weakened. However, at these same points, stresses are transferred from warp to filling and vice versa, helping the fabric to maintain integrity. When the points of interlacings are too widely spaced, the transfer of stresses is reduced, so the yarns break under stress.

The terms *on-grain* and *off-grain* denote whether or not the yarns in the woven fabric are at right angles to each other at the time the fabric is to be made into an end-use item. Off-grain alignment of the yarns yields a defective fabric. Fabrics may be pulled off-grain during dyeing, printing, and finishing operations. Usually, it is the filling yarns that are distorted. Failure to straighten the fabric—to return it to its on-grain position—results in poor drape in the end-use product.

Fabric Count

Fabric count is "the number of warp and filling yarns per inch of fabric."[2] It may be written as the number of the warp and the number of the filling ($W \times F$) or as the sum of the warp and filling counts. For example, the fabric count of a fabric with 80 warp yarns per inch and 80 filling yarns per inch can be given as either 80 × 80, 160, or 80 square. The fabric count of a fabric with 180 warp yarns per inch and 90 filling yarns per inch can be stated as 180 × 90 or as 270. Usually, the count is that of the fabric when removed from the loom, or the greige fabric. This count may change in subsequent processing.

In the consumer marketplace, fabric count is usually given on sheets and pillowcases. A common count is 80 × 80, or 160. In finer sheets, the fabric count is between 200 and 310. The more useful information is provided from the reporting of warp and filling separately because then one knows whether the fabric is balanced or unbalanced in its construction (discussed in a later section of this chapter). In mail-order catalogs, the fabric count may be printed to assist the consumer in knowing the construction of the fabric being sold.

Various adjectives are often used instead of precise counts to indicate the relative closeness of yarns in woven fabrics. These adjectives include: tight (tightly woven), close (closely woven), and dense (densely woven), as well as loose and open.

Fabric count is an important determinant of the quality of fabric. It is accepted that the higher the fabric count, the better the technological quality of the fabric. High fabric counts require the use of the finest of yarns. High fabric count is also facilitated by a low number of interlacings per square inch of fabric. If two fabrics are woven with yarns of the same size, the fabric with the fewer interlacings per inch is the higher-count fabric because yarns can be packed more closely together. High-fabric-count fabrics, although containing fine yarns, have close or dense structures that permit little yarn movement. On the other hand, yarns in low-fabric-count fabrics have some freedom of movement, enabling the fabric to better withstand the stresses of crushing and bending. Performance properties significantly affected by the fabric count appear in each of the five performance attribute categories.

Breaking strength increases as fabric count increases because more yarns are available to share the pulling force on the fabric. Tearing strength, however, decreases as fabric count increases. A tightly woven fabric allows only one yarn at a time to break as a tear propagates, but a loosely woven fabric allows more yarns to carry the load at any one time. Thus, a loosely woven fabric has a higher tear strength than a tightly woven one made of the same yarn.

Comfort is altered as fabric count increases: air permeability decreases, water resistance increases, and weight increases. The amount of fabric shrinkage decreases as the fabric count increases. Flammability is lowered as fabric count increases because less air remains within the fabric. Fabric aesthetics altered include cover, resilience, body, hand, and drape. Cover increases as

Balance

Balanced woven fabrics are fabrics that have the same number of warp yarns and filling yarns per inch and contain yarns of equal size and character. The term *unbalanced* is not defined but is commonly used to indicate that the ratio of the number of warp to filling yarns (or filling to warp yarns) in a fabric is two or greater. For example, cotton broadcloth with a fabric count of 144 × 76 and nylon satin with a count of 210 × 80 are unbalanced, with ratios of 2:1 and 3:1, respectively.

Balance is helpful in determining the warp direction of fabrics, which usually have more warp yarns than filling yarns. Some fabrics contain two or three times as many warp as filling yarns, but some contain twice as many filling as warp yarns. Balance is also helpful in determining the name of some specific fabrics that differ mainly in the balance of yarns, such as percale and broadcloth.

Raveling a fabric on two adjacent edges and looking at the density of the fringe provides a quick means of determining whether or not a woven fabric is balanced. The comparison of a balanced plain-woven fabric with two unbalanced plain-woven fabrics in Figure 26.2 is a case in point. When there is a distinct visual difference in the density of the fringe, the fabric is unbalanced. A count of the yarns is the more accurate method of determining whether or not the fabric is balanced.

Balanced fabrics are usually more durable than unbalanced ones. The yarns in a balanced fabric share the stresses placed on the fabric; hence the fabric wears more evenly. Unbalanced fabrics differ significantly in certain aspects of performance in warp and filling directions. For example, unbalanced fabrics have far greater shrinkage in the warp direction than in the filling direction. In a balanced fabric, the amount of shrinkage will differ between warp and filling directions, but the difference is smaller.

Width

Woven fabrics vary substantially in width. Hand-woven fabrics are usually 27–36 inches (69–91 centimeters) wide, a distance that represents the width through which a weaver can insert a filling yarn while sitting at the loom. Wool fabrics are traditionally 54–60 inches (137–152 centimeters) wide. Before the 1950s, cotton fabrics were limited by loom technology to a maximum width of 36 inches. Wider fabrics are more economical to cut and weave, however, so new technology was developed.

40–45 inches (101–114 centimeters) wide. Some 156-inch (396-centimeter) fabrics are available.

Narrow fabrics are defined as fabrics up to 12 inches (30 centimeters) wide. These include ribbons, elastics, zipper tapes, venetian-blind tapes, couturiers' labels, hook and loop tapes such as Velcro® (a trademark of Velcro Incorporated), piping, carpet-edge tapes, trims, safety belts, and harnesses. Webbing is a particularly important group of narrow fabrics.[3]

Weight

Woven fabrics differ in weight. In the apparel trade, the terms *top weight* and *bottom weight* are frequently used. *Top-weight* fabrics are those suitable for fabrication into shirts, blouses, and dresses. *Bottom-weight* fabrics are those suitable for fabrication into pants, slacks, and skirts. Weight might also be conveyed as *very light* (less than one ounce per yard^2), *light* (2–3 ounces per yard^2), *medium* (5–7 ounces per yard^2), *heavy* (more than 7 ounces per yard^2), or *very heavy.*

When fabric weight is given in ounces per yard^2, the area of fabric is a constant, making it convenient to compare the weights of fabrics that differ in width. Fabric weight may also be given in ounces per linear yard. The comparison of the weight of fabrics with different widths therefore requires that weight/linear yard be converted to weight/yard^2.

The heavier a fabric is, the more load that is placed on the human body wearing or carrying it. In certain end uses, such as tents for backpacking, consideration of fabric weight is paramount. The weight of a fabric influences its body; usually, the greater the weight, the greater the body. Weight is not a determinant of thermal insulation: heavy fabrics are not necessarily warmer fabrics than lighter fabrics. Thermal insulation is determined primarily by the amount of dead air space incorporated into the fabric structure.

BASIC STRUCTURES

The simplest woven fabrics are plain, twill, and satin. Each structure contains one set of filling yarns and one set of warp yarns. The repeat pattern of these fabrics is determined with as few as two yarns and with rarely more than eight yarns. The surface can appear flat (featureless), as a series of crosswise ribs, as a series of diagonal ribs, or smooth and lustrous. For each structure, a weave diagram is provided together with a photograph

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