

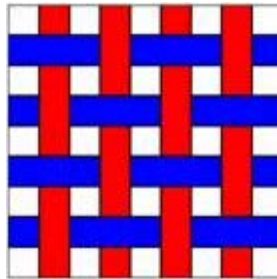
It's Not Just an Aesthetic Decision: Choosing the Right Weave Design

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A woven fabric consists of two sets of interlacing yarns which lie perpendicular to one another. The yarns can be interlaced in many different ways to produce numerous weave designs. Even with a cursory glance, an untrained eye can see a visual difference in weave designs. Much less apparent is that weaves have different mechanical properties. When choosing a weave design for a particular product, one must consider the aesthetic appearance of the weave as well as the desired properties.

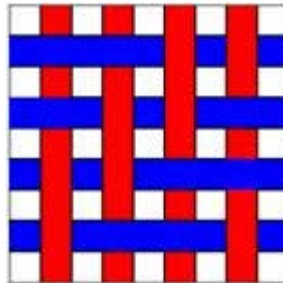
There are three basic weaves from which all other weaves are derived—a plain, twill and satin. A plain weave is considered the simplest of the three weaves. In a plain weave odd warp threads operate over one and under one filling thread, and even warp threads reverse this order, to under one, over one.

Interlacing of Warp (Red) and Filling Yarns (Blue) in a Plain Weave



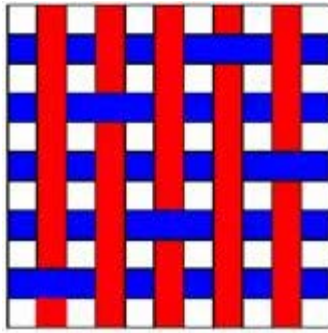
Twill weaves repeat on three or more warp and filling yarns. Twill weaves have a distinctive diagonal line on the surface of the fabric. A 2x2 twill weave is shown in the diagram below.

Interlacing of Warp (Red) and Filling Yarns (Blue) in a 2x2 Twill Weave



A satin weave is notable for its smooth surface created by the relatively long warp yarn floats. The warp yarns in a 5-harness satin float over 4 filling yarns.

Interlacing of Warp (Red) and Filling Yarns (Blue) in a 5-Harness Satin



The way in which the warp and filling yarns are interlaced not only determines the weave design but affects the mechanical properties of the fabric.

There are numerous variations of a 2x2 twill weave as well as a number of variations of a 5-harness satin. To understand the basics of how yarn interlacings affect the mechanical properties of a weave, a plain, 2x2 twill and 5-harness satin weave will be examined.

The greater the number of warp and filling yarn interlacings (or intersections) in a given area, the tighter the weave. A plain weave has the greatest number of intersections per area, and therefore is the tightest of the three weaves. A 2x2 twill weave has fewer warp and filling yarn intersections per area than a plain weave, however, more intersections per area than a satin weave. A 5-harness satin weave is the loosest of the three weaves.

SHRINKAGE:

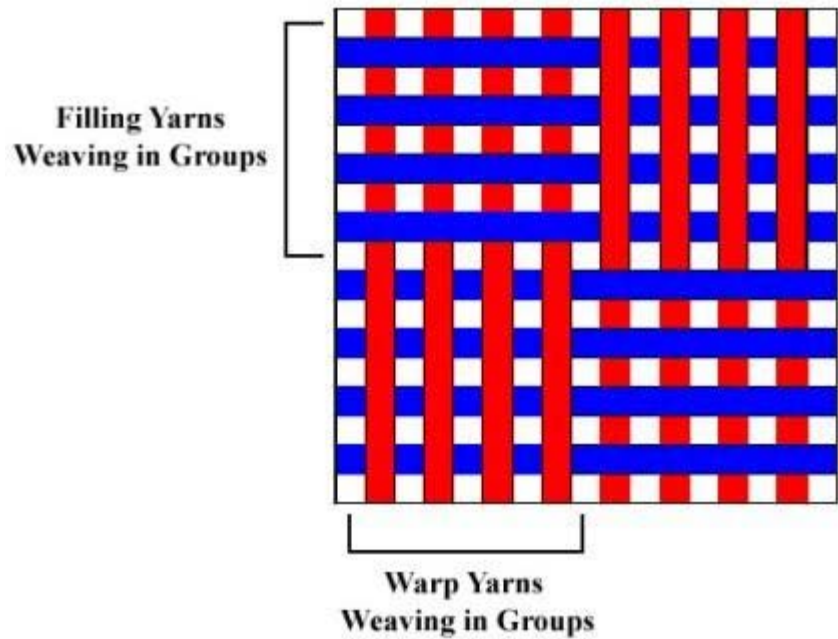
Plain < 2x2 Twill < Satin < Basket

Each of the three weaves will shrink different amounts during the finishing process. The tighter the weave or the more intersections per area, the less the fabric will shrink. A plain weave has the maximum number of intersections per area. Within a plain weave construction there is little room for the fabric to come in or shrink during finishing and therefore, will shrink the least.

A 2x2 twill is looser than a plain weave and therefore will shrink more than a plain weave. A 5-harness satin—having the fewest intersections per area, will have more room to come in during finishing, therefore will have the highest shrinkage of the three weaves.

When discussing shrinkage, one more weave should be considered. Although basket weaves are a derivative of a plain weave, the way in which the warp and filling yarns are interlaced produces unique shrinkage properties. Both the warp and filling yarns weave in groups, creating juxtaposed floats. The existence of the floats enables the fabric to easily come in during finishing—producing a high degree of shrinkage.

Interlacing of Warp and Filing Yarns in a 4x4 Basket Weave



PROPENSITY TO TEAR

Plain > 2x2 Twill > Satin

The ease with which a fabric tears is dependent on two variables—the amount of yarn slippage or mobility of the yarns within the fabric construction and the number of yarns which will bear the load. These two variables are determined by the number of interlacings per area within the fabric construction.

The greater mobility or the ease with which the yarns are able to move, the harder it is to tear the fabric. In addition, the greater the number of yarns that will bear the load, the harder it will be to tear the fabric.

Out of the three weaves, a plain weave will tear the easiest. A plain weave is a tight construction having the least amount of internal slippage or yarn mobility. In addition, only one yarn bears the load when the fabric is torn.

The illustration below illustrates the concept of load bearing during tearing. It can be seen from the diagram that as a plain weave is torn, there is one yarn present to resist the tear.

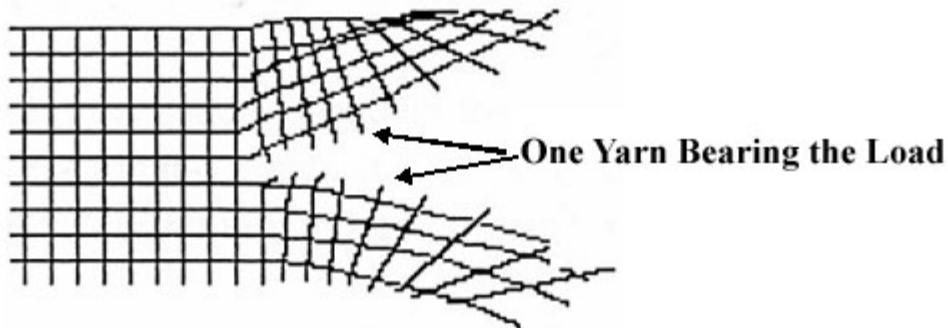


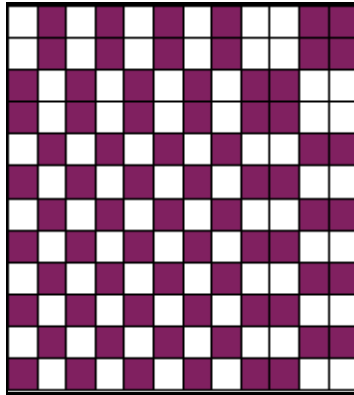
Illustration of a Plain Weave being Torn

It should be noted that a plain weave can be modified to increase the resistance to tearing. By inserting fewer filling yarns during weaving, a looser construction is produced. The looser construction will be harder to tear because it will allow for more internal mobility or yarn slippage.

A 2x2 twill will have a higher resistance to tearing than a plain weave because it has fewer yarn interlacings per area, therefore a greater degree of internal mobility. In addition, two yarns will bear the load when the fabric is torn.

The relatively few number of intersections per area within a 5-harness satin allows for more yarn slippage than in a plain or a 2x2 twill. In addition, 4 yarns bear the load during tearing. A 5-harness satin has the highest resistance to tearing.

It is interesting to note that weaves can be combined to enhance performance. For example, a parachute fabric utilizes a plain, rib and basket weave to produce a durable fabric. The plain weave imparts strength and stability to the fabric. The rib and basket weaves are incorporated to increase the resistance to tearing.



Parachute Fabric Combines Plain, Rib and Basket Weaves

EXTENSIBILITY

Plain > 2x2 Twill > Satin

Extensibility refers to the degree with which a fabric will increase in length under tension. Different weaves have different degrees of extensibility. The amount of crimp within the fabric construction plays a roll in determining the extensibility of a fabric.

Crimp is defined as the waviness or distortion of a yarn due to the interlacings within the weave. The higher the number of interlacings per area the greater the crimp. A plain weave has the greatest number of interlacings in a given area, and therefore the highest degree of crimp. A plain weave will extend more than a 2x2 twill or a 5-harness satin weave.

A 2x2 twill, having the second highest number of intersections per area will have the second highest extensibility followed by a 5-harness satin. In general, the longer the floats within the construction the less extensible the fabric will be.

WRINKLE RESISTANCE

Plain < 2x2 Twill < Satin

The ability of a fabric to resist wrinkling is determined by the amount of mobility the fibers and yarns have within the construction. The more freedom they have to move, the easier it is for them to return to their relaxed state or the state they were in before deformation. The tighter the weave, the less freedom the yarns and fibers have to move.

Yarns and fibers within a plain weave construction have little freedom to move about limiting their ability to recover after deformation. A plain weave will have the least resistance to wrinkling. A 2x2 twill will have the second highest recovery followed by a 5-harness satin weave.

Today, many sheeting manufacturers utilize a satin weave instead of a plain weave. The ability of a satin weave to resist wrinkling after home laundering is a desirable feature to the customer.

PROPENSITY TO PILL

Plain < 2x2 Twill < Satin

Pills are balls of entangled fibers which become attached to the fabric surface. The entangled balls are from fibers sloughing off onto the fabric surface. In a tight weave the fibers will be less likely to slough off—resulting in less pilling. Plain weave fabrics will be the least likely to pill, followed by a 2x2 twill, followed by a 5-harness satin.

DRAPE

Plain < 2x2 Twill < Satin

Draping is defined as the ability of a fabric to hang in graceful folds. Tight constructions have little mobility and do not drape as well as looser constructions. For this reason plain weaves will not drape as well as a 2x2 twill. A 5-harness satin will have the best drape.

PROPENSITY TO SNAG

Plain < 2x2 Twill < Satin

The propensity to snag is one of the most obvious properties. The shorter the floats, the less likely the fabric will be to snag, therefore a plain weave will snag the least, followed by a 2x2 twill and finally a 5-harness satin weave.

SURFACE TEXTURE

Plain > 2x2 Twill > Satin

In general, the more interlacings per area, the more surface texture. This would imply that a plain weave would have the most surface texture, followed by a 2x2 twill. A 5-harness satin, with its relatively long floats is the smoothest of the three weaves. Satin weaves are often used as the base fabric for printing. Their smooth surface allows for thorough coverage of the ink

PICK PER INCH

Plain < 2x2 Twill < Satin

Due to the high number of intersections per area in a plain weave, fewer picks can be inserted into the fabric. A greater number of picks can be inserted into a 2x2 twill weave, and even more can be inserted into a 5-harness satin weave.

Sheets which utilize a satin weave often advertise a high thread count—much higher than sheeting constructed with a plain weave. Due to the comparatively low number of intersections per area within a satin weave, more picks can be incorporated into the fabric than in a plain weave. A higher thread count in a satin sheet does not necessarily mean a higher quality product.

As mentioned earlier, in a basket weave, the warp and filling yarns weave in groups. This unique trait allows more picks to be incorporated into a basket weave than either a twill or a satin.

It is worth noting that there are numerous variations of twill and satin weaves. The mechanical properties will vary depending on the number of intersections per area.

When determining the mechanical properties of a particular weave, the number of intersections per area must be considered.

Fabric technologists have long been aware of the different mechanical properties associated with different weaves. When choosing a weave design for a specific product, it is important to not only consider the aesthetic appearance of the weave, but the desired mechanical properties as well.

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