Chiffon and taffeta fabrics/ photo by Petra Haikonen

This open educational resource has been developed by:

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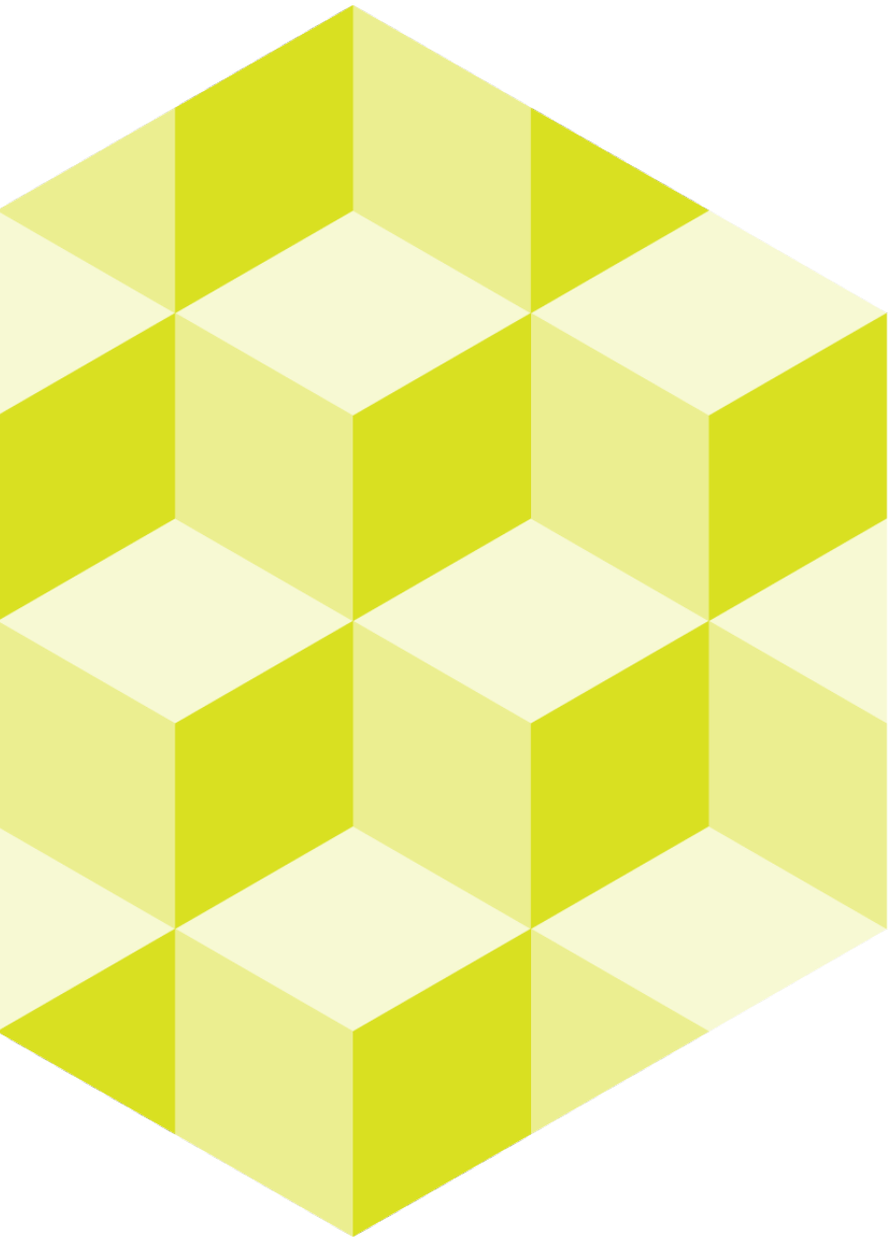
Metropolia UAS

3.1 Basics of Woven Fabrics

SusTexEdu

Funded by the Erasmus+ Programme of the European Union



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This learning material was developed in the Erasmus+ funded project Education Partnership of Textile and Clothing Sector Materials & Sustainability (SusTexEdu)

The goal of the project is to research and develop education in the textile and clothing sector related to textile materials, sustainability and circular economy.

The learning material has been prepared for piloting, and students will be asked for voluntary feedback after the course for the further development of the material.

Project Coordinator: Metropolia UAS
Partners: Hogent (BE), Mome (HU), Omnia (FI), TTHK (EE), TTK UAS (EE), University of Borås (SE)
Funding: Erasmus +
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About this learning material:

This learning material was partly piloted with 1st year students of Fashion and Clothing bachelor's degree programme at Metropolia UAS (level 6) on their course Textile Fibers and Clothing Materials (5 ECTS). The theoretical course was held on-site.

This learning material is targeted for students that require basic knowledge about apparel textiles to understand the connection between the fabric structure and product longevity.

The learning unit does not have any prerequisites, and the students are not required any previous knowledge of the topic.

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About this learning unit

CONTENT DESCRIPTION

- The basics of weaving and technical terms
- Different production methods
- Basic woven structures
- Fabric trade names and contexts of use

LEARNING OUTCOMES

Student will be able to:

- understand the weaving technology and different production methods
- understand the differences between the woven structures
- analyse and select appropriate woven fabrics for specific function or context of use
- understand the connection between the fabric structure and product longevity

STUDENT WORKLOAD

The learning unit is 2 ECTS, which equals approx. 54 hours of work:

- contact teaching 12h
- group activities 8h
- independent assignment 6h
- assignment presentations 2h
- small quiz 1h
- independent work 25h

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Content of the learning unit

Plain weave / photo by Petra Haikonen

1 Theory of weaving and manufacturing

Basics of Woven Fabrics
PART 1

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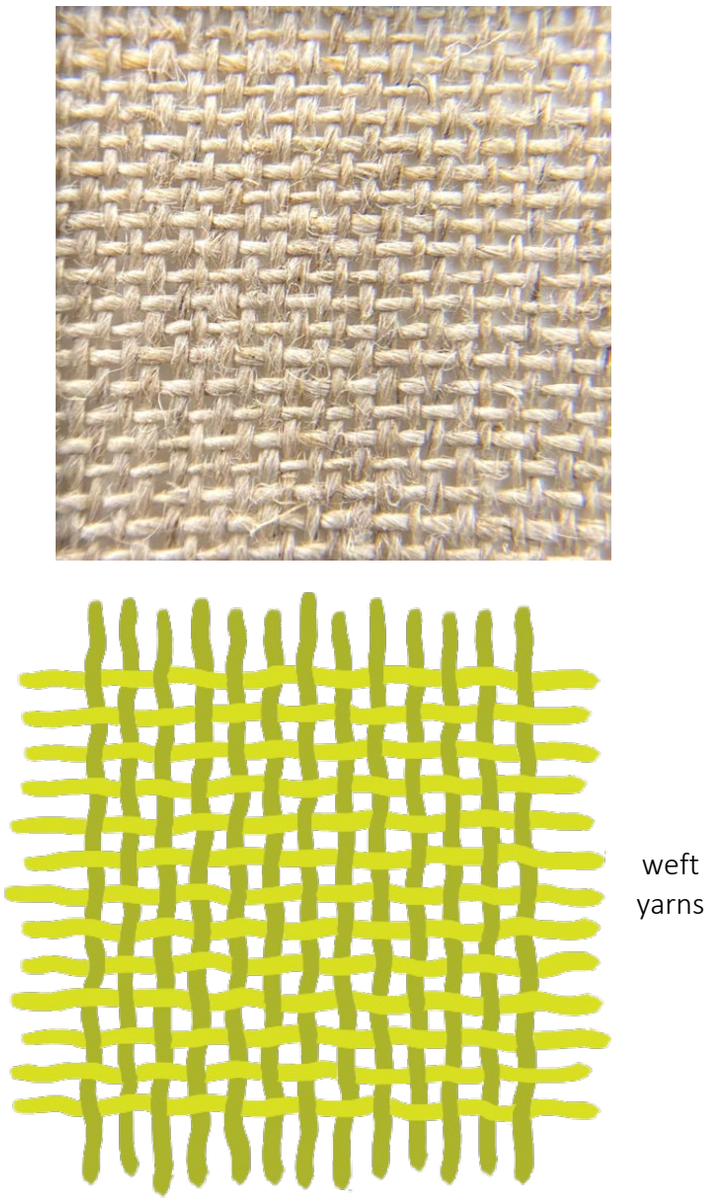
Introduction to weaving

Woven fabrics consist of **two or more sets of yarns** interlacing with each other creating a structure. **Warp yarns** (also referred as ends) run vertically as the length of a fabric, and **weft yarns** (also referred as picks) run horizontally as the width of a fabric.

Woven fabrics are manufactured on a **loom** where warp yarns are prepared and set before weaving and are tensioned so that the weft yarns can go over and under warp yarns resulting a **weave structure**.

Depending on the used structures woven fabrics may be very similar on both sides, or they may have a **face** where a weave structure, a print or a finishing is more prominent than on the **back**. Some woven fabrics may also have a top and a bottom if the woven pattern is one-directional, or the finishing creates a difference to the look (e.g. corduroy).



Woven plain weave fabric (top) and an illustration of the same structure (bottom) / images by Petra Haikonen

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Properties of woven fabrics

The final look, hand and weight (g/m2) of the fabric depends on the following factors:

- weave structure
  - the interlacement of warp and weft yarns
- used yarns in warp and weft
  - the properties of the used yarns (the fibre content, ply, twist, weight, structure etc.) affect the final fabric greatly
  - warp yarns are set on the loom before weaving, and are generally more durable than weft yarns
- fabric density (also referred as thread count or fabric count, yarn sett or warp and weft densities)
  - affects to the hand and weight of the fabric
  - a balanced fabric has the same densities in warp and weft direction
  - note that the used weave structures influence on the maximum number of yarns per cm (weaves with fewer interlacements, such as satins, enable yarns to pack more resulting a denser fabric)
- finishings
  - mechanical and chemical finishings
- yarn colours
  - in weaving it is possible to create all kinds of patterns by using at least two different coloured yarns
  - colours in a yarn-dyed fabric influence the appearance of the weave structure and the final look greatly

Basics of weaving process

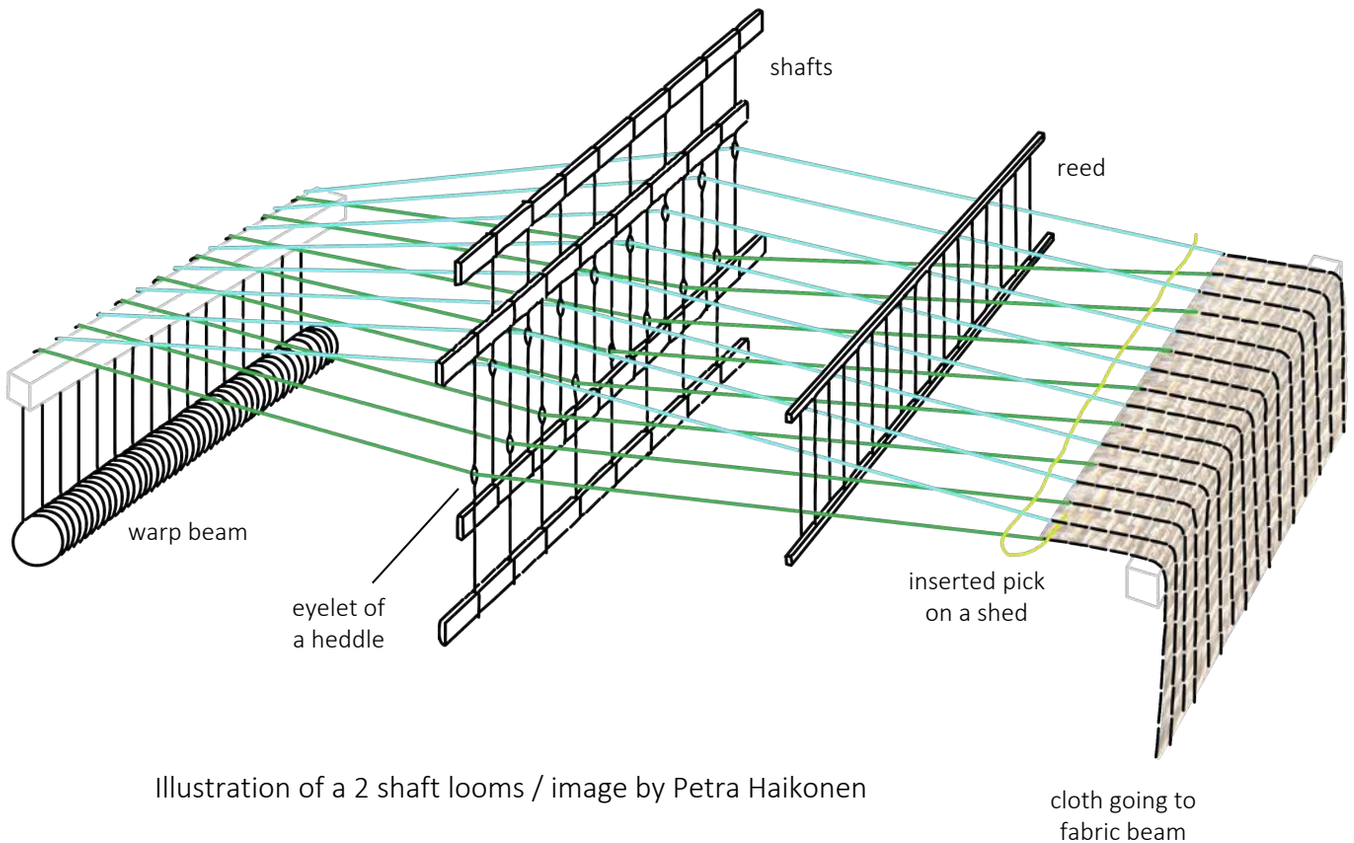


Illustration of a 2 shaft looms / image by Petra Haikonen

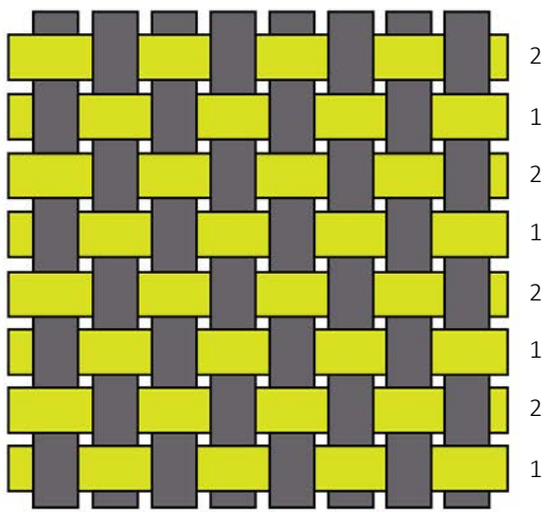
All loom types serve the same purpose: to hold the warp yarns under tension and in parallel while the weft yarns are inserted to the shed. There are all kinds of loom types from a body tension loom (or belt loom) to treadle and dobby looms used in hand weaving to industrial weaving machines.

Prior to weaving the warp is made and warped on a **warp beam** on the back of the loom. Then the warp yarns pass through **shafts or harnesses** (referred simply as harness in industrial machines) where each warp yarn is threaded through an **eyelet of a heddle** and is controlled by that shaft/harness. When one or more shafts/harnesses are raised, and one or more shafts/harnesses are lowered, a **shed** is formed where the weft yarn is inserted with a **shuttle** (with shuttleless industrial machines the mechanism of inserting weft varies). At least two different sheds are required to create a **weave structure**. A **reed** keeps the warp in a correct warp density and pushes the weft into the produced fabric with a correct weft density. In front of the loom is a **fabric beam** (also referred as cloth roll) where the produced fabric or cloth is being rolled into.

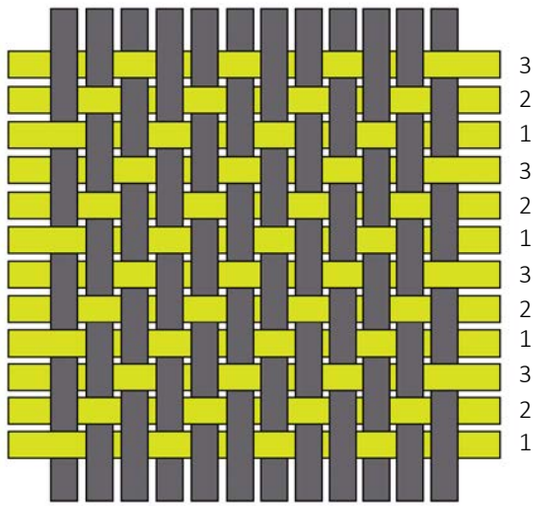
Number of shafts in weaving

With treadle and dobby looms, the number of shafts determines the possible weave structures to be woven.

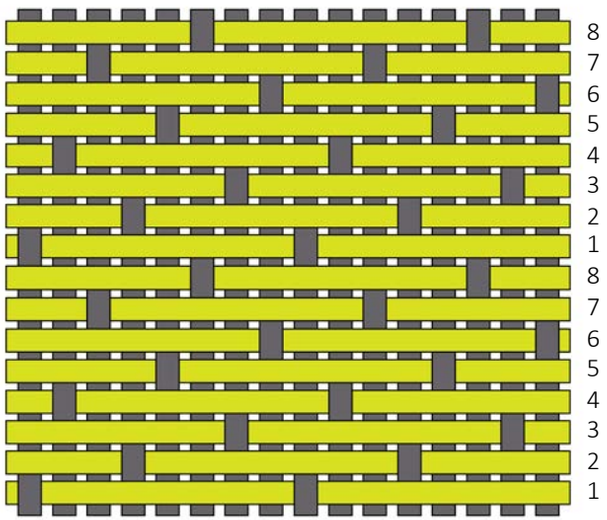
Plain weave,
minimum 2 shafts



Warp-faced twill weave,
minimum 3 shafts



8-end weft-faced satin weave,
minimum 8 shafts



Illustrations of different weaves / images by Petra Haikonen

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Industrial looms

There are two types of industrial looms: conventional **shuttle looms** and **shuttleless looms**. Industrial shuttle looms have more narrow weaving widths and a slower production speed, and therefore they have mostly been replaced by shuttleless looms. There are four types of shuttleless looms: **rapier**, **air-jet**, **water-jet**, and **projectile** looms depending on the mechanism how the weft is being inserted.

While the shuttle transfers the continuous weft yarn from one shed to the next resulting woven selvedges to the sides (e.g., with selvedge denim production, image on top), shuttleless looms insert and cut the wefts in each row leaving fringes on the sides. Air-jet and rapier looms are most popular in the industry. Air-jet looms have the highest production speed (up to over 2000 rpm (revolution per minute, equals picks per minute), but slower rapier machines (image below) have more versatility with the used weft yarns.

Selvedge denim / image by Wizz Von der Wham from Pixabay

Industrial rapier machine with jacquard harness at Aalto University, Espoo / image by Petra Haikonen

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Shuttle vs. shuttleless looms

Conventional shuttle looms:

Also called fly shuttle looms, conventional shuttle looms are less frequently used than shuttleless looms, because they are noisy and slow. Still e.g. some denim producers favour shuttle looms for creating selvedge denim.

Moving the heavy shuttle requires more energy, and it may also create defects in the produced fabric. On the other hand, the production can stand a more uneven yarn quality.

Shuttleless looms:

Compared with conventional looms, shuttleless looms are quieter, faster and more energy efficient. Therefore, they are replacing shuttle looms from the industrial production.

Also, the production costs are lower since one person can operate several machines at the same time, because the weft yarns run from cones instead of shuttle bobbins.

The fabric quality is more consistent since the mechanism of placing the weft to a shed is smaller than with shuttle, and therefore the shed does not need to open as wide.

Dobby vs. jacquard looms

Both loom types are much used in the industrial manufacturing of woven fabrics. The difference between dobby and jacquard looms is how the warp yarns are operated. With dobby looms there is a limited number of shafts where the warp yarns are threaded, and the shaft selection for each pick is operated by a mechanical dobby chain, or nowadays more often by a computer. The used structures and patterns depend on the number of shafts used in the looms (see page 10).

With jacquard looms, invented by Joseph Marie Jacquard in 1804, each individual warp yarn can be independently operated, since they are threaded to independent heddles instead of shafts. That results a bigger repeat size and large-scale patterning. The number of hooks in the jacquard control unit determines the final repeat size. Equal number of hooks attached to heddles with a harness cords as the warp yarn count results a full width repeat.

Industrial rapier machine with a 2 repeat jacquard harness where one hook operates 2 heddles simultaneously / image by Petra Haikonen

Preparation and setting the looms

Weaving requires time-consuming and labour-intensive warp preparation and setting the looms prior to weaving production. Therefore, weaving mills are usually specialised in certain types of fabric qualities and have standardised loom settings.

Warping can be made as **sectional warping process**, where narrow width yarn bands are first wound on a warping drum, and from there the warp is beamed to a warp beam. Also, **direct warping** straight to warp beam can be used. Some natural and man-made staple fibre warps may undergo a **sizing process** where starch or other agents are added to the warp yarns to make them more durable during the weaving process. Fabrics woven with sized warps need to be desized after weaving.

A whole new warp needs setting up with a **drawing-in** process, where each warp end in drawn through a **drop wire** (lamella), a **heddle** (held), and a **reed**. This stage is very labour-intensive, so changing the warp to identical number of ends is more quickly made with a warp knotting machine.

Warp knotting machine being used while changing the warp beams / image by Petra Haikonen

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Sustainability aspects of manufacturing

The environmental load of weaving can be difficult to evaluate since it depends on the used machinery and the yarns. However, weaving has higher environmental load than the production of nonwoven fabrics because of the required yarn processing stage that is needed prior to weaving manufacturing. Also, there are several preparation and post-weaving processes that require high amounts of energy and specific machinery.

One of the largest environmental loads in the production of woven fabrics is the energy consumption of the machinery. Depending on the production country, the energy production method may differ greatly, which affect the environmental load. Manufacturing of woven fabrics also consumes water due to required high humidity at the premises and possible sizing of the warp and desizing processes. Sizing process in the preparation phase also consumes a lot of heat energy, so the environmental load can be reduced by using cold sizing agents and reduced steam temperatures, or by skipping the whole sizing process by using superior quality yarns in warp.

Sustainability aspects of manufacturing

The latest developed air-jet weaving machines have high production speed (multiple compared to other machines) however, they consume very high amounts of energy due to the compressed air usage. Also, with shuttleless looms the fringes, that are created from the extra weft yarns cut on the sides, are considered production waste if it's not recycled. One should also note, that with weaving it is very difficult to produce seamless products, and therefore also the cutting and sewing processes need to be added to the environmental load of woven products.

It is impossible to entirely remove the environmental load from any textile manufacturing operation, but it is possible to reduce it with technology improvements and by selecting the appropriate manufacturing methods considering also the product's end-use and its longevity. The high durability of the woven fabrics (incl. abrasion resistance) increases the longevity compared to many other fabric production methods.

References

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Johnson, I., Cohen, A. & Sarkar, A. *J.J. Pizzuto's Fabric Science* (London: Fairchild Books, 2015), 86–117.

Palamutchu, S. *Textiles and Clothing Sustainability* (Hong Kong: Springer, 2017), 14–15.

Salolainen, M. *Interwoven* (Espoo: Aalto ARTS Books, 2022), 41, 61–77.

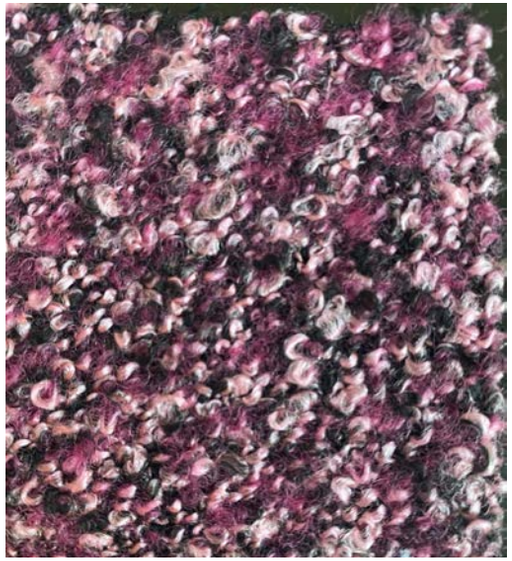
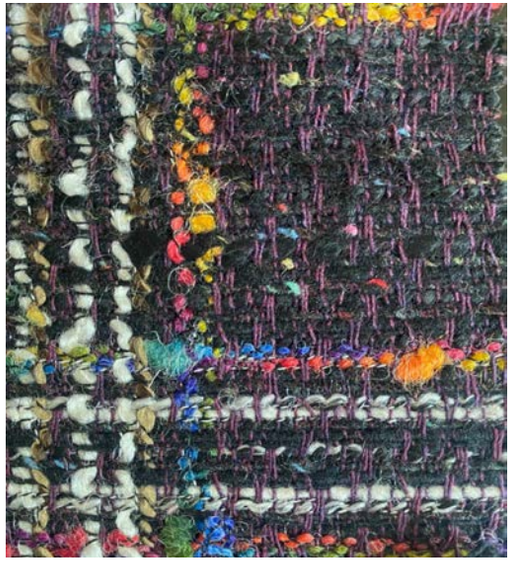
Stankard. S. "Yarn to Fabric: Weaving" In *Textiles and Fashion: Materials, Design and Technology*, edited by R. Sinclair (Cambridge: Woodhead Publishing Limited, 2014), 255–287.

Extra video material from YouTube to support teaching (not CC-licenced videos) e.g.:
Weaving process: *Weaving Machine Animation and Basic Principle of Weaving*
Shuttle weaving machine: *Selvedge Denim vs. Normal Denim*
Rapier weaving machine: *DORNIER Weaving Machine P2 Upholstery fabrics*
Air-jet weaving machine: *Air jet weaving. Tsudakoma running with 2300 Picks per Minute. ITME2022*
Water-jet weaving machine: *How does the water jet loom complete the beating?*
Jacquard weaving: *How was it Made? Jacquard weaving*

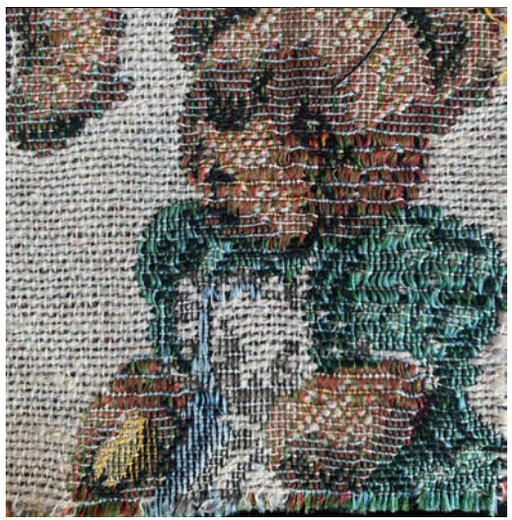
Small assignment: group work (on-site)

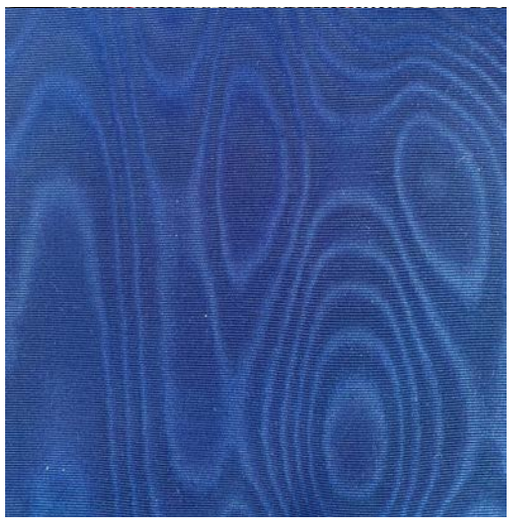
Analyse woven fabric samples on-site (reference images on the next slide).

- Examine the used warp and weft yarns. How are they used to create the properties and the pattern of the fabric?
- Examine the used production methods. Define whether they are woven on a dobby or a jacquard machine.







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Chiffon fabric / image by Petra Haikonen

2 Weave Structures and Fabric Trade Names

Basics of Woven Fabrics
PART 2

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Introduction to Weave Structures and Fabric Trade Names

Fabric trade names are used in the textile and fashion industry to identify fabrics. The used trade names can come from used weave structures (e.g., herringbone twill), used materials (e.g., batiste vs. voile), fabric weight (chiffon vs. georgette), used finishes (e.g., flannel), or even the origin of the fabric (e.g., damask originated from the city of Damascus).

There is a huge variety of weaves used within woven fabrics, but the following weave structures and some fabric trade names presented next are chosen due to their popularity in the apparel industry. The first introduced structures are the three **basic weaves**: plain weave (with derivatives basket and rib weaves), twill weave and satin weave. Finally, some **textured weaves** and more complex **compound weaves** are presented shortly.

It can be quite tricky to categorise fabrics sometimes, since also the descriptions may vary with different references.

"Selecting a textile fabric that is best suited for a particular use involves knowledge of each of the components and an understanding of textile properties in finished fabric."

– Johnson, I., Cohen, A. & Sarkar, A. J.J. Pizzuto's Fabric Science, 2015, p. 340

Basic weaves – Plain weave

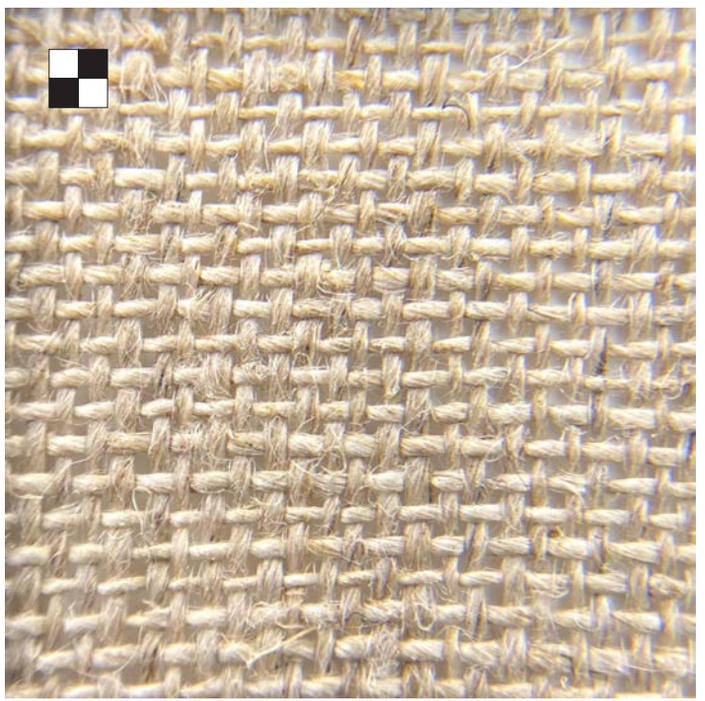
Simplest form of weaving, over one under one

Plain weave is the oldest and one of the most used weave structures. Plain weave has the maximum number of intersections (interlacement of warp and weft), which makes the fabric generally strong and less likely to slip than fabrics with weaves with longer yarn floats.

The look is smooth and balanced, and therefore plain weave is ideal for printed fabrics and fabric finishings such as pleating.

Characteristics of plain weave fabrics (considering only the weave structure, not yarn quality):

- good dimensional stability and abrasion resistance
- less elasticity
- good body but weaker drape
- may wrinkle more because of high number of intersections



Close-up image of plain weave burlap fabric / image by Petra Haikonen

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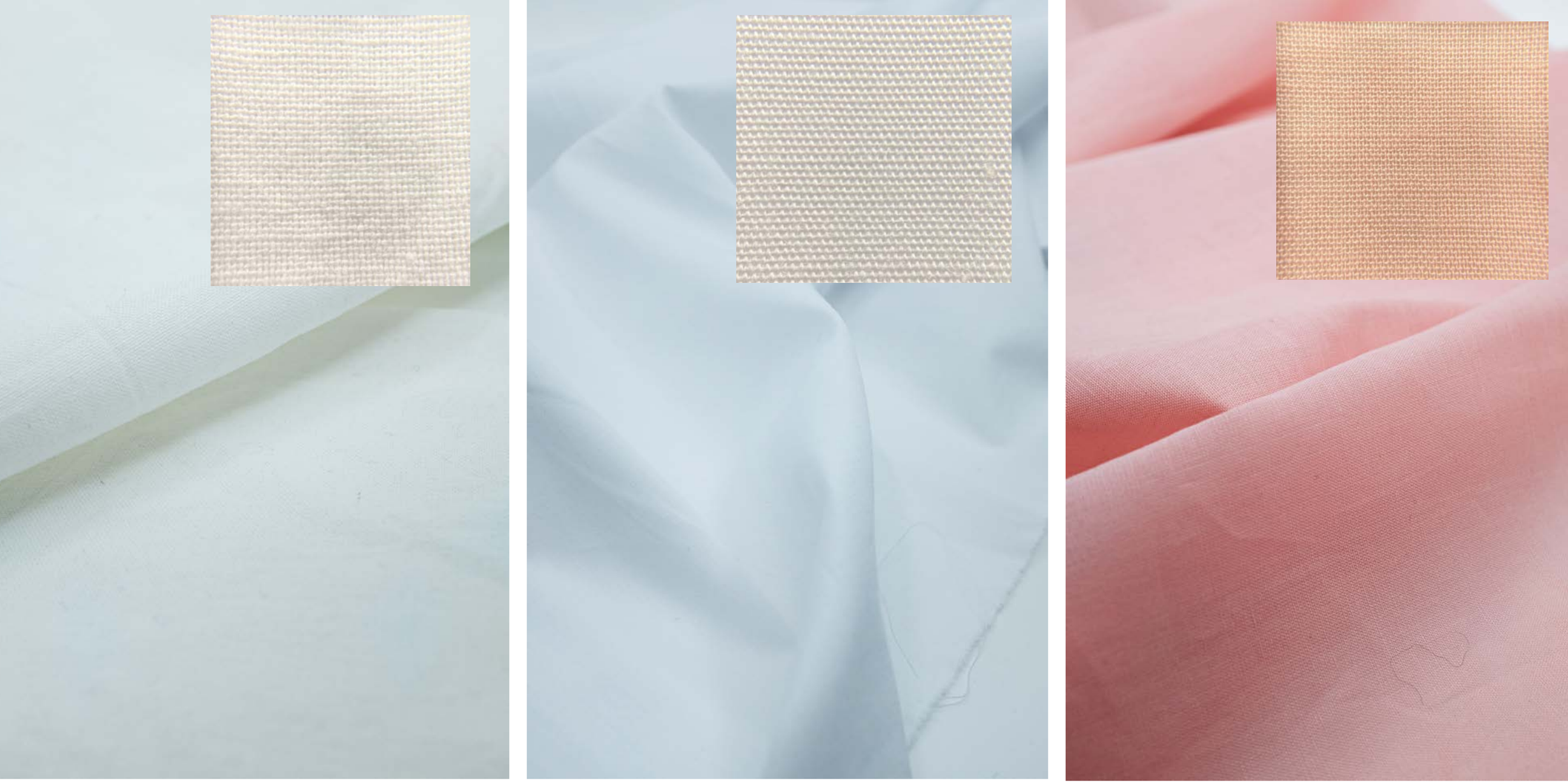
Basic weaves – Plain weave

Some of the fabric names and qualities used in clothing:

- Batiste
  semi-opaque, lightweight, soft hand with high count, made with cotton, linen or blends
- Chambray
  light to medium-weight, balanced fabric similar to denim with coloured warp and white/unbleached weft
- Chiffon
  very lightweight, transparent fabric made with high-twist filament yarns for crepey hand (lighter than georgette)
- Chintz
  medium-weight, tightly woven cotton fabric with shiny finishing made often
- Flannel (can also be twill weave)
  mid- to heavy-weight, usually cotton or wool, napped finishing on one or both sides of the fabric
- Gingham
  light to mid-weight with two-coloured (white and coloured yarns) warp and weft stripes that result as a check pattern, usually cotton or blend
- Muslin
  Usually fine, soft balanced plain weave fabrics made commonly from cotton, wool or silk; may also refer to a textured cheesecloth
- Organza
  lightweight, sheer fabric that has been stiffened for crispy feel; high quality organzas are made with silk
- Seersucker
  plain weave fabrics created with slack-tension weaving with two separate warp beams (one in normal tension and the other in looser tension), where the looser tension warp stripes create permanent puckering when wefts are woven to the fabric; usually made with cotton or cotton blends and used in lightweight clothing; ideal for summer fabric because the puckering allows air between the fabric and skin
- Voile
  lightweight, sheer fabric with hard-twisted yarns and slightly crip hand



Basic bed sheet fabric (left), tighter shirting fabric batiste (middle), and thinner and more drapeable voilé (right); all fabrics 100% CO / images by Petra Haikonen

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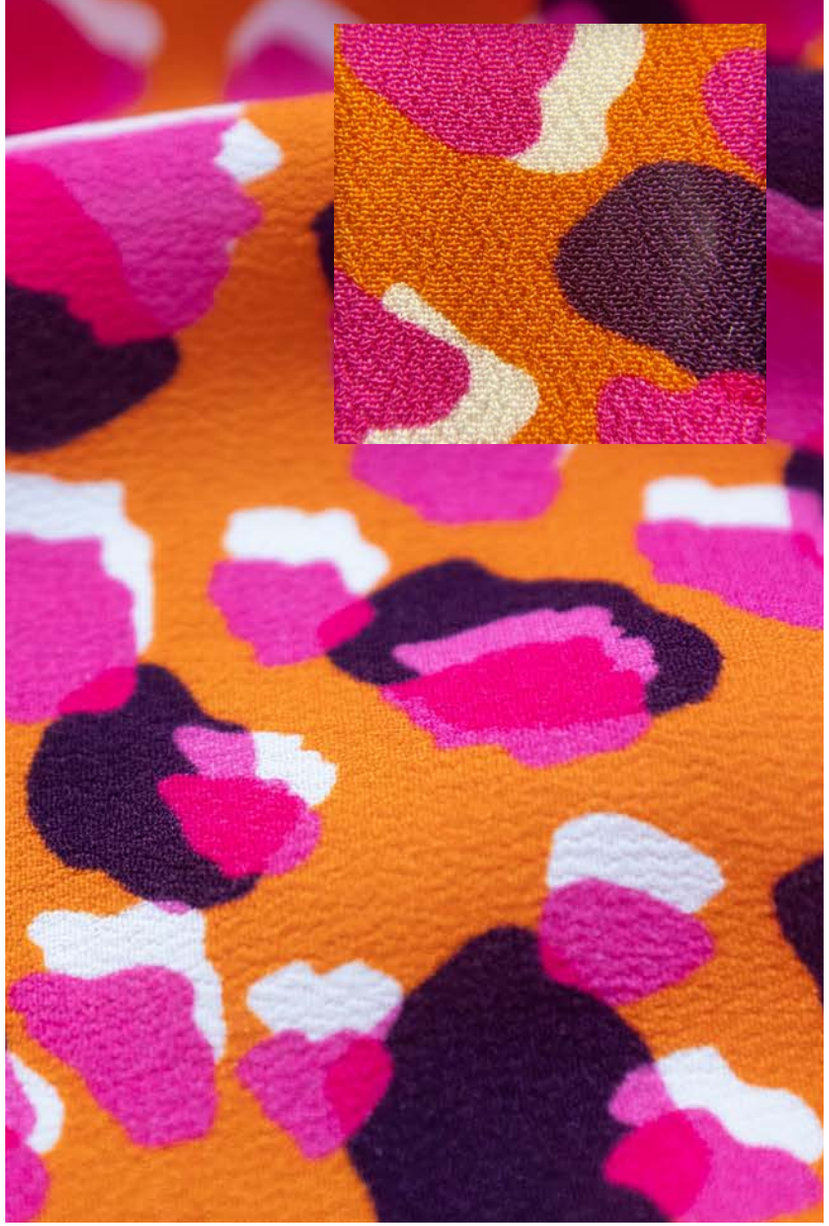

Thin and flowy chiffon (left), thicker and more grainy georgette (middle), and thin and more crispy organza / images by Petra Haikonen

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Brushed plain weave flannel (left; note that the pattern on this is printed), chequered two-coloured gingham (middle), and chequered seersucker shirt made by Komodo (right) / images by Petra Haikonen

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Plain weave derivatives – Rib weaves

Unbalanced weaves with visual rib lines on the surface

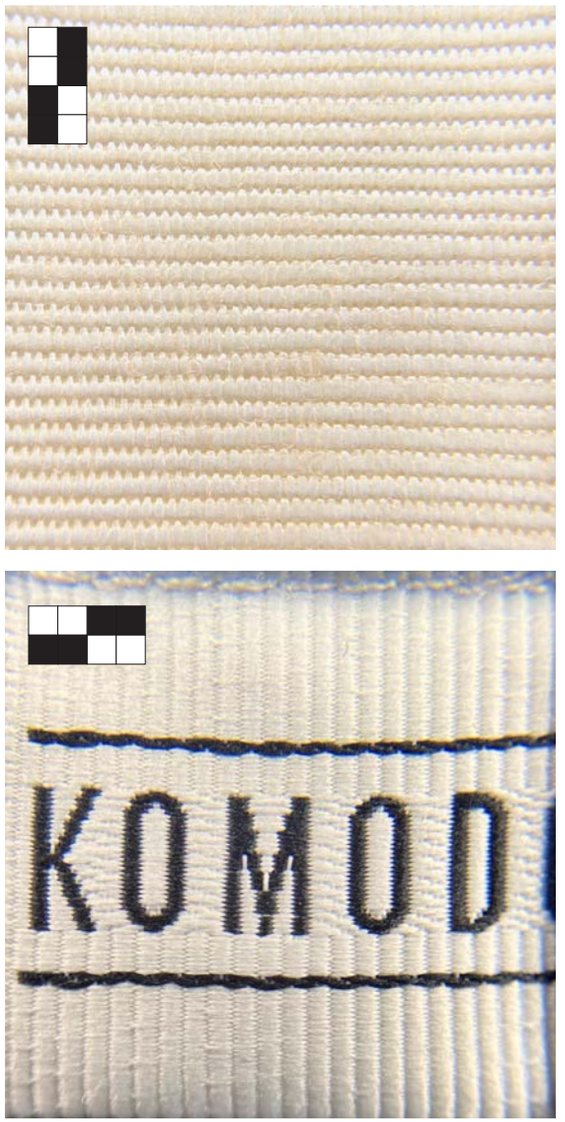
Rib weaves are unbalanced weaves with visual rib lines on the surface. The weave structure can be same as plain weave, or with unbalanced ratio of warp and weft yarns.

If the rib line is horizontal, then the rib weave is considered warp-faced rib. There, either the weft yarns are considerably thicker than the warp yarns, or wefts are multiplied in the same shed. If the rib line is vertical, the rib weave is considered weft-faced rib. There, either the warp yarns are considerably thicker than weft yarns, or warps are multiplied in the same shed. Vertical ribs are more common in interior products, such as carpets.

The rib can be very visible (as in ottoman fabric), easily visible (as in poplin), or less visible (as in taffeta). However, with all these fabrics the rib can be traced by touching the fabric.

Characteristics of rib weave fabrics (considering only the weave structure, not yarn properties):

- rib weaves are commonly tightly woven fabrics with high strength and durability
- horizontal rib weaves have good structure and body, but weaker drapability whereas vertical rib weaves have better drape
- tend to wear more easily than plain weave fabrics due to the three-dimensional ribs being exposed to abrasion (can be compensated by using hard twisted yarns as in poplin)
- may have yarn slippage if the covering set of yarns move (especially in areas of stress, such as seams)



Close-up images warp- faced rib (top) and weft-faced rib for Komodo's shirt label (bottom) / images by Petra Haikonen

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Plain weave derivatives – Rib weaves

Some of the fabric names and qualities used in clothing :

- Poplin (warp-faced rib or unbalanced plain weave)
  light- to mid-weight fabric with a visible rib woven with spun yarns; it has a crispy sound when touching the fabric
- Taffeta (warp-faced rib or unbalanced plain weave)
  light- to mid-weight, tight and crisp rib fabric made with filament yarns; the iridescent effect of taffeta can be created by using opposite colours from the colour wheel in warp and weft in making the fabric to shift colours OR by mixing two weft colours with very fine warp yarn (as in image on the next page)
- Ripstop (weft-faced rib/occasional rib weave)
  evenly spaced heavier yarns in both warp and weft directions resulting a grid-like pattern; very strong and durable fabric used in outerwear, accessories, etc

Close-up image of ripstop fabric /
image by Petra Haikonen

Tightly woven poplin shirting fabric (left), stiff and crispy taffeta (middle; note! double weft with green and pink filament yarns), and printed ripstop fabric by Foxa / images by Petra Haikonen

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Plain weave derivatives – Basket weave

Balanced, multiple-yarn configuration

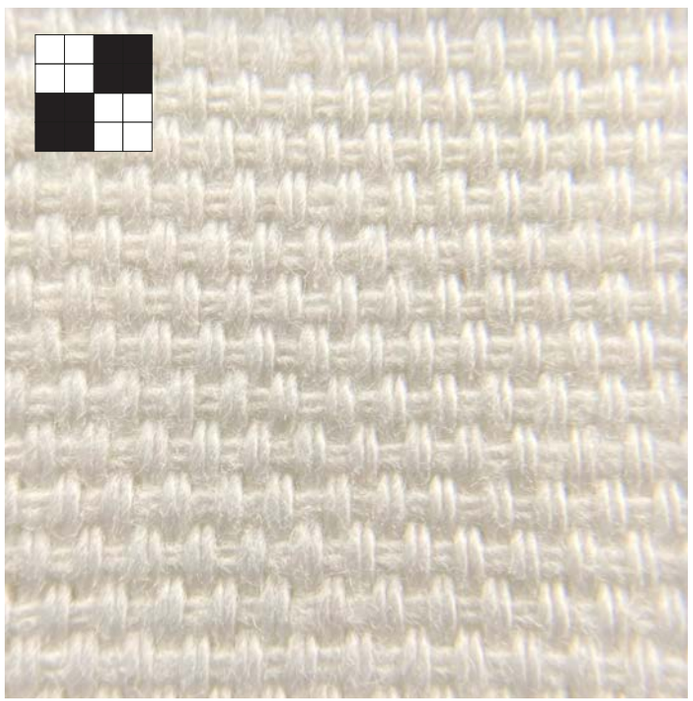
Basket weave has a similar balanced look as with plain weave, but it has a multiple-yarn configuration meaning it is woven with two or more wefts over and under two or more warp yarns. Common ratios for basket weave are two-to-two or four-to-four.

It has less intersections than plain weave, so more yarns can be packed together resulting in sturdy fabrics, such as canvas.

A variation of basket weave is half basket with two-to-one ratio, but the look is still balanced by using thinner warp yarns than weft yarns, such in Oxford cloth which is 2:1 basket.

Characteristics of basket weave fabrics (considering only the weave structure, not yarn properties):

- better elasticity and resistance to wrinkles than plain weave
- reduced dimensional stability, may fray and stretch more than plain weave
- more flexible than plain weave



Close-up image of 2:2 basket weave / image by Petra Haikonen

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Plain weave derivatives – Basket weave

Some of the fabric names and qualities used in clothing :

- Hopsack
  medium-weight quite loosely woven basket weave fabric made from wool, cotton, or linen used e.g., in suiting and jackets
- Panama / Canvas
  heavy-weight basket weave fabric, often used with bags
  can also refer to a heavy half basket or even plain weave fabric
- Oxford
  light- to mid-weight fabric with half basket structure made from cotton or blends

White 2:2 basket weave (left), and black plain weave fabric (right); both of them are canvas fabrics / images by Petra Haikonen

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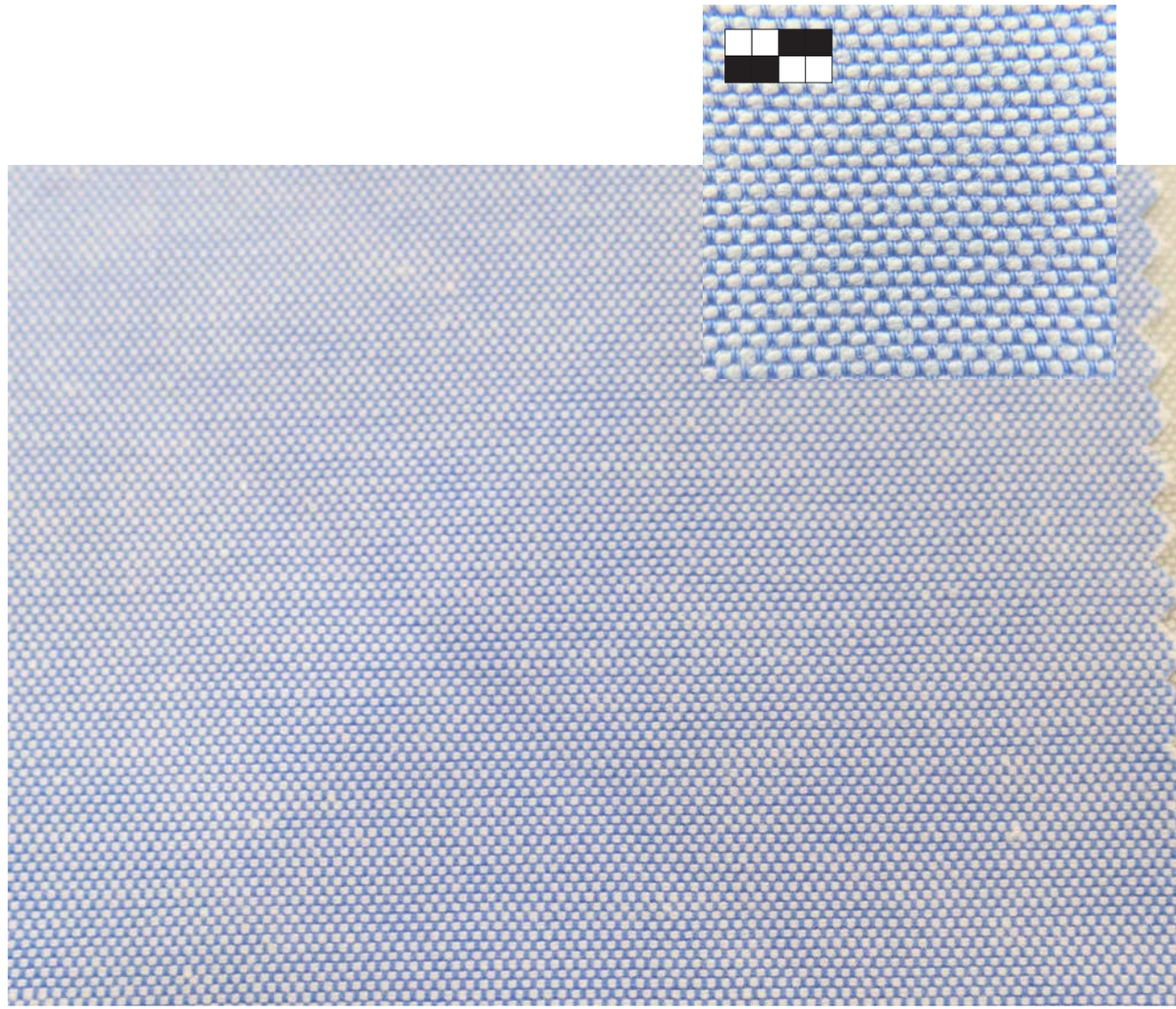

Shio´s pants made of hopsack-styled fabric with loose half-basket (left), and sample fabric of Oxford fabric with half-basket (right) / images by Petra Haikonen

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Basic weaves – Twill weaves

Noticeable diagonal twill lines

Twill weave fabrics have distinct diagonal lines (wales) on the surface of fabric with either warp of weft floats. A balanced twill has the same amount of warp and weft visible on the face, though twills can also be warp- or weft faced.

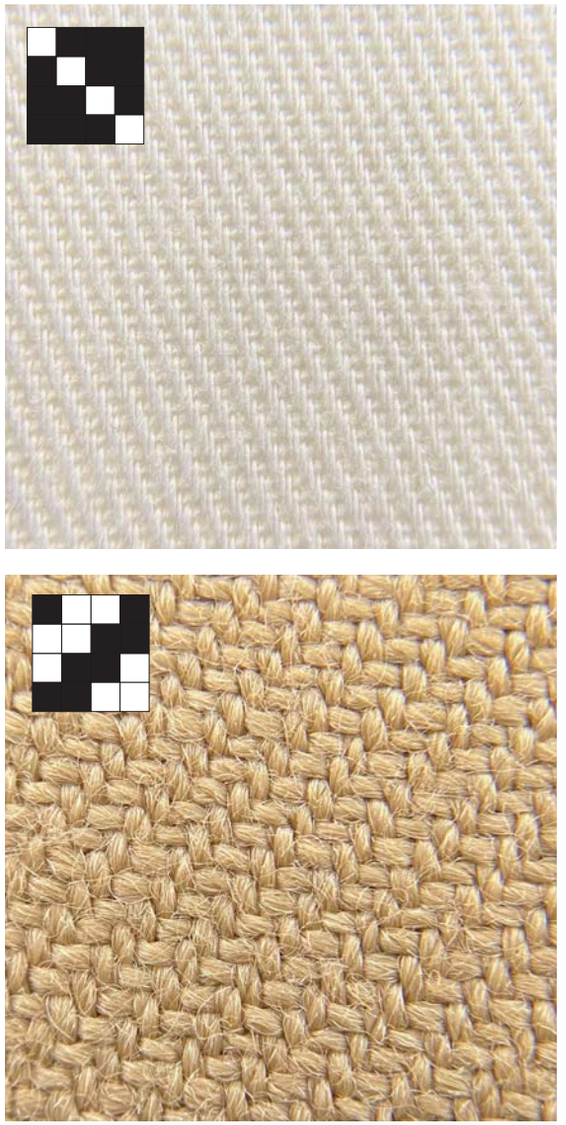
Regular twill has 45° angle diagonal line, steep twill with diagonal line higher than 45°, and reclining twill with diagonal line lower than 45°. As the higher yarn density affects the angle of the twill line, fabrics that require higher durability are often steep twills (such as gabardine with very high warp count).

Wale direction: the right-hand twill runs from lower left corner to upper right corner while left-hand twill with twill line running upwards to the left.

Pointed twill and broken twill: the twill lines may change direction resulting a zigzag pattern. In pointed twill the zigzag pattern is solid (chevron) and in broken twill the zigzag pattern is broken and reversed (herringbone). There are also many more patterned variations of twills available.

Characteristics of twill weave fabrics (considering only the weave structure, not yarn properties):

- generally more tightly woven resulting a strong fabric with good abrasion resistance; therefore, twill weave is often used in workwear, outerwear and suiting
- usually softer feel and better drape, more wrinkle resistant than plain weave
- twill fabrics with dominant wales may look shinier with wear when the wale flattens (can happen e.g., with gabardine)



Close-up images of 3/1 warp-faced twill (top) and balanced 2/2 twill (bottom) / images by Petra Haikonen

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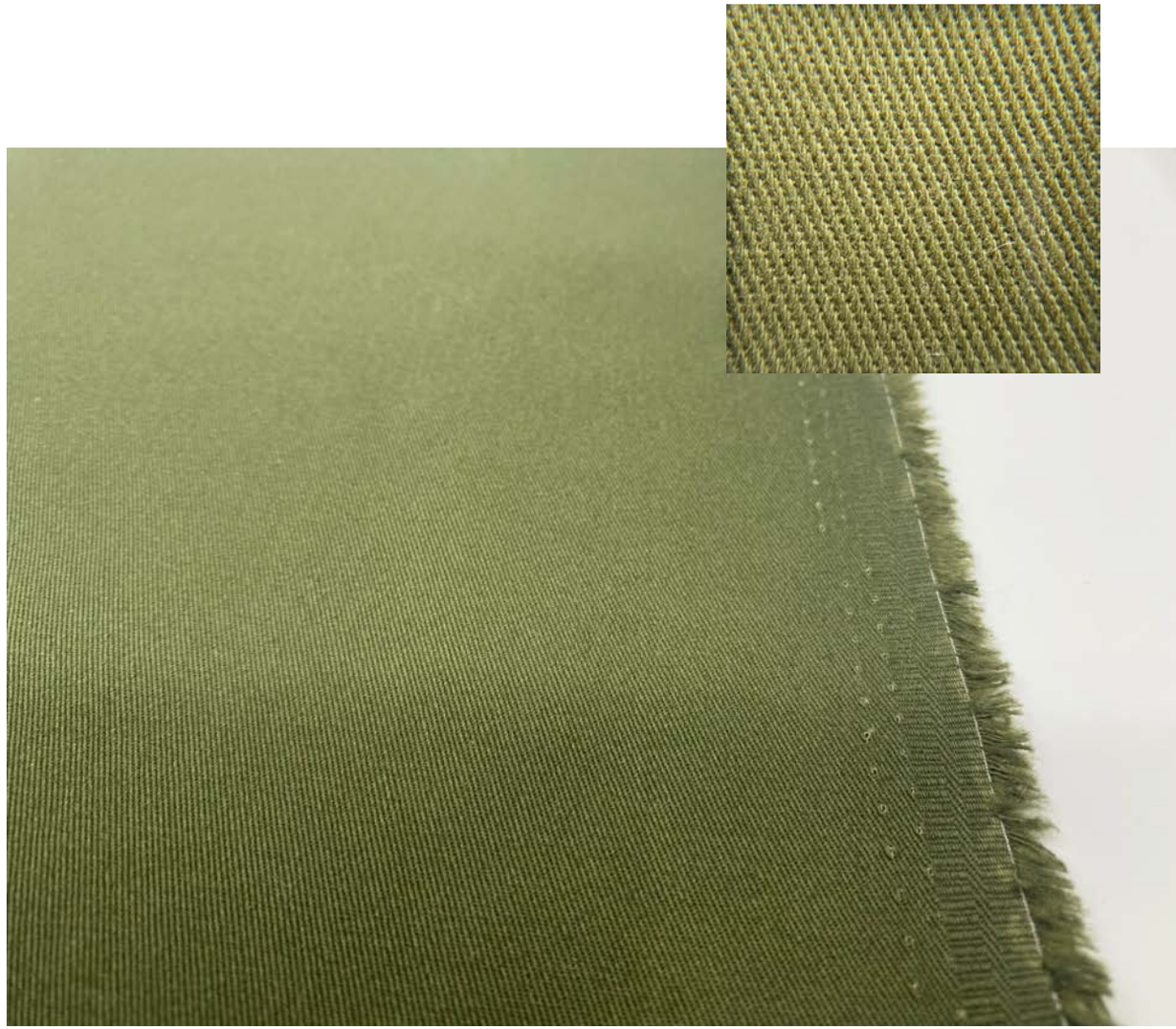
Basic weaves – Twill weaves

Some of the fabric names and qualities used in clothing :

- Denim
  2/1 or 3/1 warp-faced twill with usually indigo-dyed warp and white picks, many weights, usually cotton or blend (in the image next page 3/1 warp-faced twill)
- Gabardine
  medium-weight, warp-faced twill with steep twill line, originally developed for raincoats
- Herringbone
  medium- to heavy-weight, reversing twill with a V-shaped pattern but with a break at the reversal; many tweed fabrics are woven as herringbone twills, but tweed can also be a plain weave with wool yarns and rough hand
- Houndstooth
  a balanced, regular twill but with both warp and wefts as two-coloured stripes resulting a distinct pattern
- Glencheck
  similar to houndstooth but with several thickness colour stripes in both warp and weft direction results in complex chequered fabric
- Tartan
  check-patterned fabric traditionally used in Scottish kilts



Denim with 3/1 warp-faced twill (left), gabardine with steep twill (right) / images by Petra Haikonen

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Houndstooth pattern with 8-end balanced twill & 2-coloured stripes (left), herringbone with broken twill (middle; with also brown pointed twill fabric), and chequered clencheck with 4-end balanced twill and varying stripes / images by Petra Haikonen

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Basic weaves – Satin

Smooth and silky with enhanced drape

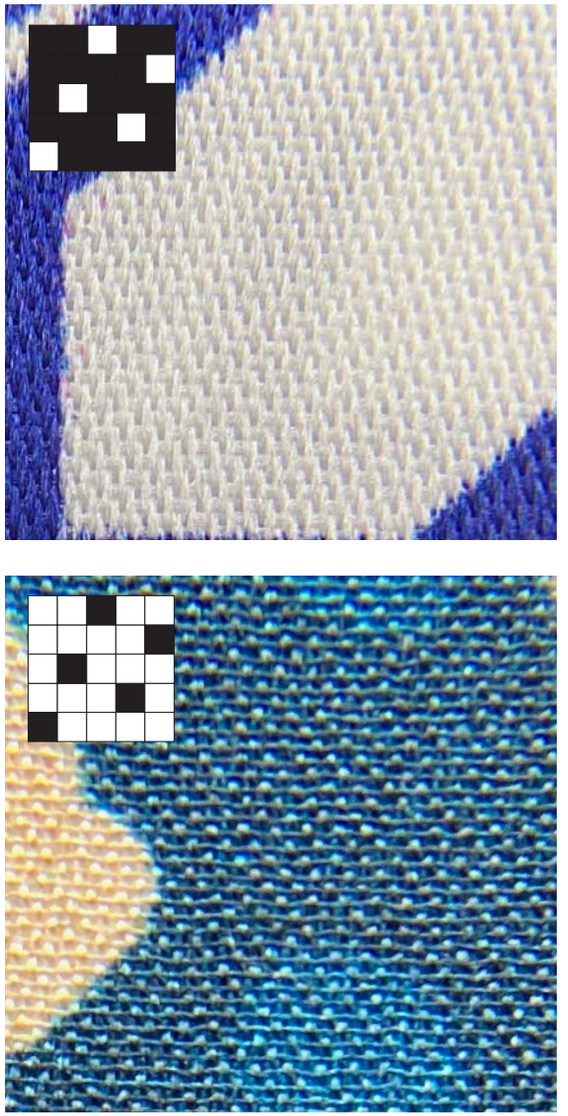
Satin weaves have one yarn system dominant in the face of the fabric with longer floats (4 or more yarns) and one intersection point (stitcher). The stitchers are spaced so that the surface of the fabric looks smooth and even.

In warp-faced satin the face of the fabric is predominately covered with warp yarns, and in weft-faced satin the face is covered with weft yarns. Therefore, satin weave enables the material characteristics of the covered yarn to become the main feature of the fabric. Satin fabrics are usually made with filament yarns (such as silk), which emphasize the lustre effect that results from the weave structure. Sateen fabrics are usually made from spun yarns.

The smallest and the most common satin structure is five-harness (or five-shafts or 5-end) satin.

Characteristics of satin weave fabrics (considering only the weave structure, not yarn properties):

- weave structure allows the yarns to pack resulting a high thread count (referred also as close sett)
- lustrous, smooth and silky hand with excellent drape, therefore satin is popular with many end-uses in apparel and interior, such as evening dresses, lingerie and curtains
- compact, smooth and flat fabric surface, often used for garment linings
- long floats in the structure can cause snagging and seam-slippage (higher pick and end densities may help improve durability)
- higher tread counts can result in extremely durable and dense fabrics, such as sateen used for military combat uniforms, or blackout curtains that can block 100% of the entering light



Close-up images of warp-faced satin (top) and weft-faced satin (bottom) / images by Petra Haikonen

Basic weaves – Satin

Some of the fabric names and qualities used in clothing :

- Satin
  made of filament yarns, usually warp-faced satin weave with smooth and lustrous look
- Double-faced satin
  two sets of warp yarns and one weft yarn forms a fabric with warp-faced satins in both face and back
- Satin crepe
  satin fabric with textured yarn as weft formulates grainy surface to the surface; thin and drapey fabrics
- Sateen
  durable fabric made of spun yarn such as cotton, weft-faced satin weave fabric with less lustre and drape than other satin fabrics
- Moleskin
  made of carded cotton, moleskin is very dense and tight weft-faced satin that is brushed and finished for suede appearance; used in products of high wear resistance

The same silk fabric with prints on both weft-faced satin side (left, more matte look) and warp-faced satin side (right, shinier look) / images by Petra Haikonen

A sample of satin crepe with grainy texture on the warp-faced side due to textured weft (left), and a double-faced duchesse satin with both sides as warp-faced satin (right) / images by Petra Haikonen

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Textured weaves – crêpe weave

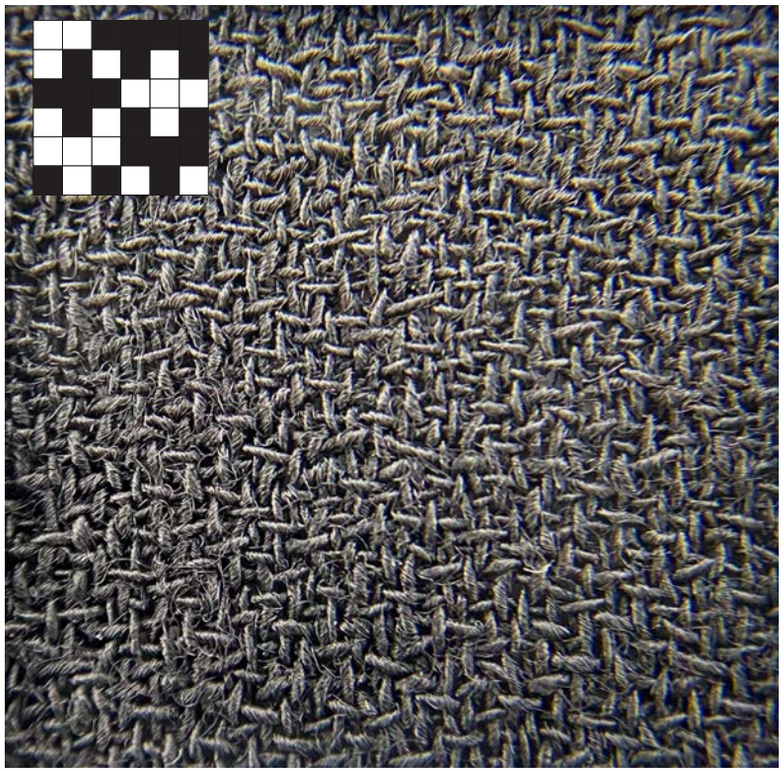
All-over textured look

Crêpe weaves (also referred as momie weaves) are small-scale non-directional patterned weaves that can be created by deriving or combining basic weaves with irregular intersection points. That results a grained and crinkled surface with both warp and weft yarns equally visible on the face of the fabric.

As a fabric name crêpe (or crepe) can also be used as a general term for all fabrics with a crepey look. Instead of using a crêpe weave structure, the crepey look can be created with plain, rib or satin weave by using a special yarn structure (alternating over-twisted S- and Z twist yarns in both warp and weft direction (effect visible in the finishing washes), or using textured filaments), or by using special finishes, such as plissé or embossing.

Characteristics of crêpe weave fabrics (considering only the weave structure, not yarn properties):

- great drape and elasticity, not as high thread count as with satin due to irregular intersection points
- grainy or rougher hand, less lustre



Close-up image of wool crêpe fabric / image by Petra Haikonen

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Textured weaves – crêpe weave

Some of the fabric names and qualities used in clothing :

- Crepe suiting / Wool crepe
  mid- to heavy-weight fabric; wool crepe is made of wool or wool blends, but crepe suiting can also be made of silk, polyester or blends; used in all kinds of clothing
- Crepe georgette
  may be either a crêpe weave or a plain weave with overtwisted S-twisted and Z-twisted yarns in both warp and weft; heavier than chiffon; also heavier wool crepe fabrics may be called as crepe georgette

Heavier fabrics with crêpe weaves, black is wool crepe, printed is blend (left), plain weave fabrics with crepe finishes (right; fabrics from left 100% PES, 100% SE and 100% CV) / images by Petra Haikonen

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Textured weaves – waffle weave

Three-dimensional honeycomb look

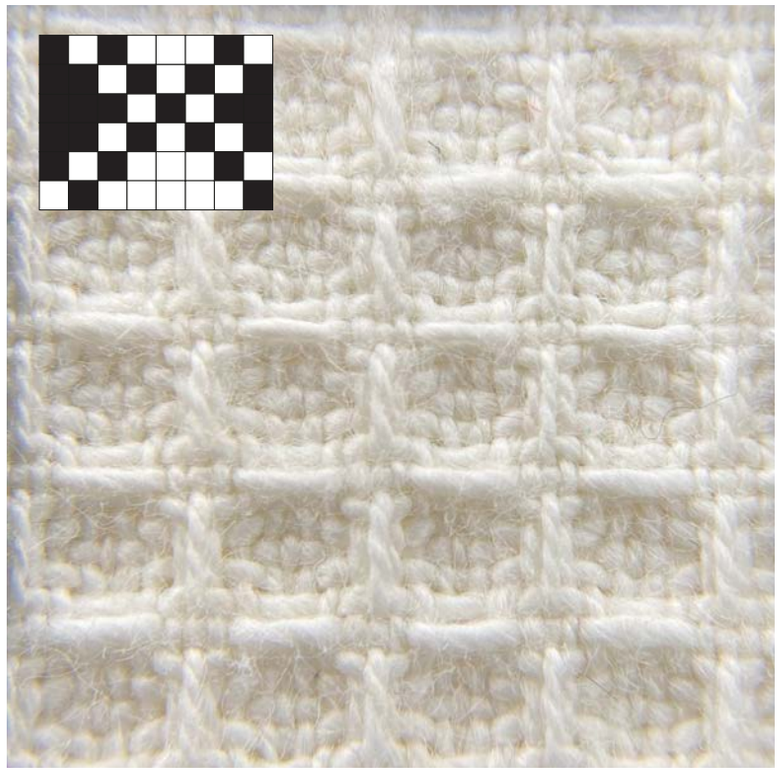
Waffle weave (also referred as honeycomb) combines patterned areas of loose warp and weft floats with tightly bound plain weave outlining the waffle's distinctive honeycomb shapes. Because of the combination of loosely and tightly bound areas, the surface becomes three-dimensional after the fabric is taken out of loom tension.

Waffle weave may also be categorised as a dobby weave or dobby pattern, because of the weave structure's repeating geometric pattern.

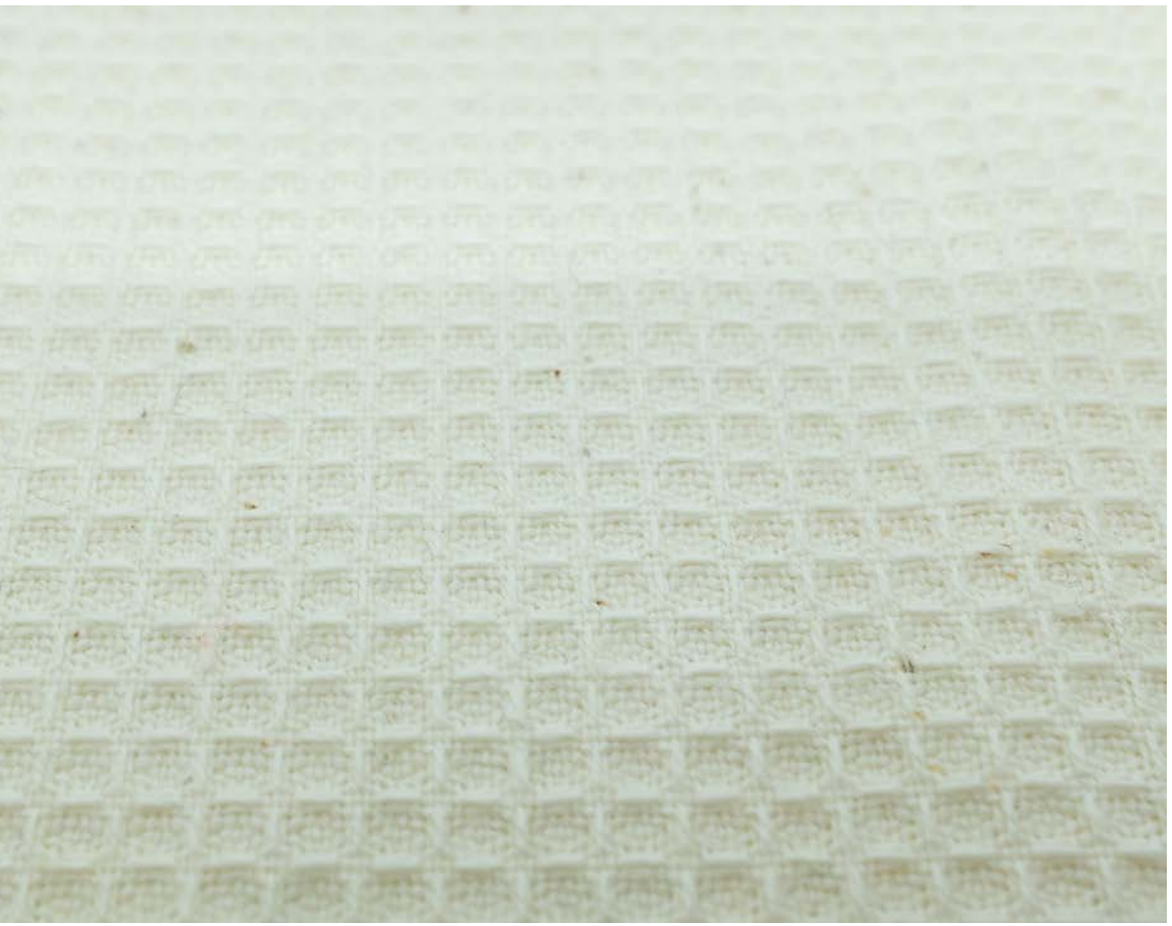
With fabric names waffle weave is always considered as either **waffle cloth** or **honeycomb**.

Characteristics of waffle weave fabrics (considering only the weave structure, not yarn properties):

- great insulating properties especially when woven with wool yarns; popular weave structure for blankets
- absorb moisture well; great for robes and other bath textiles



Close-up image of waffle fabric with warp and weft floats and plain weave areas, image by Petra Haikonen



White waffle fabric (left), and a bathrobe with waffle structure, 43% CLY, 39% LI, 18% CO (right) / images by Petra Haikonen

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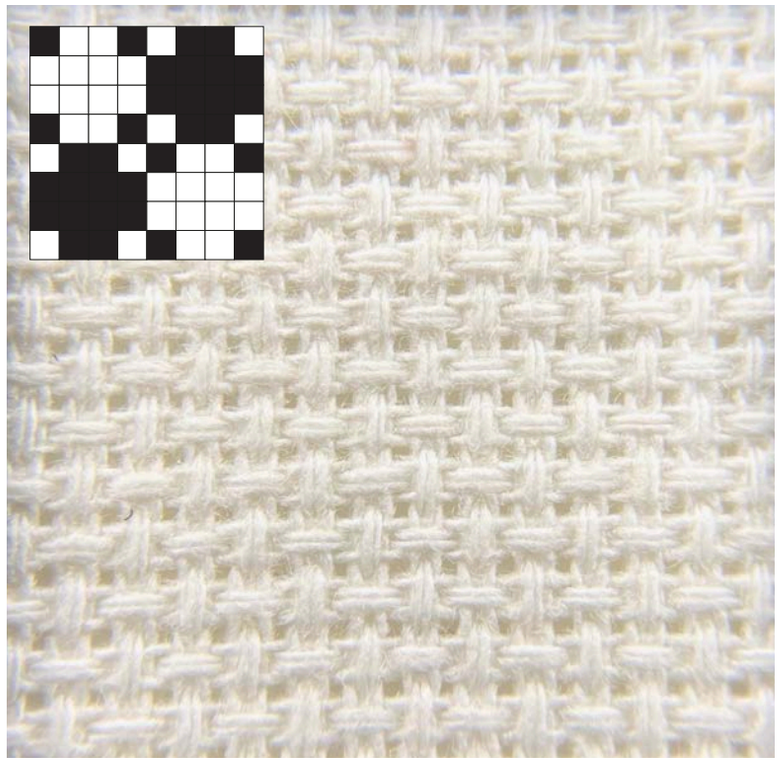
Textured weaves – mock leno weave

Fabric with tiny holes

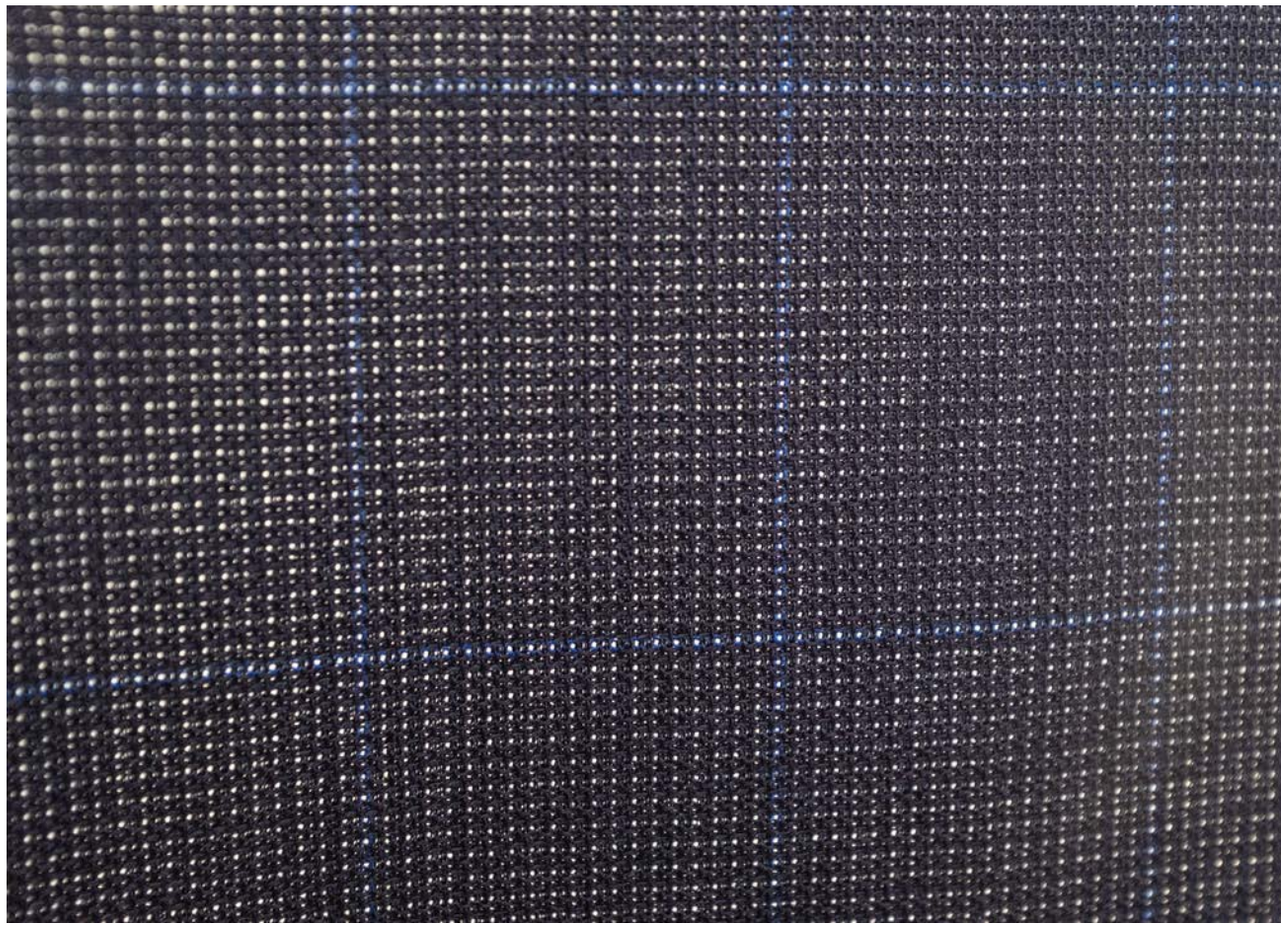
Mock leno (also referred as etamine) is a plain weave derivative that is an open weave structure. It combines small groups of alternating picks and ends resulting a pattern with inverted areas. Those groups then push themselves away from each other because of internal structural friction. That causes the empty areas in between the warp and weft groups to form resulting a gauze-like texture.

Characteristics of mock-leno weave fabrics (considering only the weave structure, not yarn properties):

- Similar look on both sides
- Sheer look due to the open structure; great for summer blouses, dresses and lightweight curtains



Close-up image of mock leno fabric with warp and weft groups and holes in between, image by Petra Haikonen



Different thicknesses mock-leno fabrics used in embroidery (left), and check pattern mock-leno fabric for top-weight garments / images by Petra Haikonen

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Combining weaves and advanced structures

Elaborate patterns and colours

Combining weaves refer to a large scale of structures quite often resulting as decorative fabrics. A **combination weave**, such as a damask, combines two or more weaves with different looks to create a pattern. A **compound weave**, such as a double weave, combines weaves with a dedicated set of warp yarns and/or weft yarns. Combination and compound weaves can be woven with dobby and jacquard looms.

Jacquard is a general term referring to fabrics that are woven on a jacquard loom, that can operate each warp yarn individually. The jacquard loom was first invented by Joseph Marie Jacquard in 1804. Jacquards are usually patterned, complex fabrics that combine at least two different weaves, and can also combine several warp and weft systems with almost unlimited variations.

Characteristics of compound weaves and jacquard fabrics (considering only the weave structure, not yarn properties):

- patterned woven fabrics with several different weaves or weft materials or colours combined
- may be heavier than fabrics with basic weaves

Close-up image of damask with warp-faced and weft-faced satin structures / image by Petra Haikonen

Combining weaves

Some of the fabric names and qualities used in clothing :

- Brocade
  complex in structure and colours, made with many weaves and colours combined as extra-weft patterning; authentic brocade fabrics can only be woven by hand with individual shuttles for precious gold and silver threads, but nowadays brocades can be woven industrially by imitating the method with fil coupé technique
- Damask
  patterned fabric with one set of weft yarns and one set of warp yarns; patterns created by combining warp- and weft-faced satin or twill weaves
- Double cloth / backed weave
  two sets of warps and wefts creating two layers of fabrics that are stitched together while weaving; often quite heavy-weight due to at least four sets of yarns in the same fabric
- Double weave / pocket weave
  two sets of warps and wefts creating two layers of fabrics that shifts from face to back within a pattern creating pockets; often quite heavy-weight due to at least four sets of yarns in the same fabric
- Double-faced weave
  three sets of yarns; either two sets of warp yarns and one weft, or two sets of weft yarns and one warp; e.g., double-faced satin with warp-faced satin weaves on both sides of the fabric
- Matelassé
  a double weave structure with a three-dimensional look that is created with open double weave pockets and tightly stitched structures combined; puckering effect can be emphasised with a heavier filling weft or by using shrinking yarns in one cloth

White damask fabric with warp- and weft-faced satins (left), and a jacquard fabric with both double-faced and double-weave areas (right) / images by Petra Haikonen

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This double-faced fabric is woven with one warp yarn (blue) and three weft yarns (light blue, green & yellow) /
image by Petra Haikonen

Open pocket structures with thicker wadding weft results as heavy three-dimensional matelassé fabric used in bed covers /
image by Petra Haikonen

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Summary and sustainability aspects

“The ability of textile structures to resist wear is an important feature of textile material in the future fields of applications. The factors of fibre, yarn and fabric construction should specifically be noted.”

– Petrulis, D. Understanding and improving the durability of textiles, Part 1 Aspects of textile durability, 2012, p.24

The construction of a fabric whether it is woven, knitted or nonwoven affects greatly to the durability of that material in use. Therefore, it is vital to understand different manufacturing methods and the differences of structures to make as sustainable and long-lasting choices as possible. Whether one is working as a textile or a fashion designer, a technician, or e.g., in marketing in the textile and clothing sector, everyone has a responsibility to understand how the textiles are produced, and how the structural and material choices affect to the quality and longevity of that textile in a particular use.

Summary and sustainability aspects

The fabric durability builds upon a combination of used fibres, the yarn construction, the fabric construction (such as a weave structure), and the used finishings. With the studies about fabric durability, it has been pointed out that denser fabrics are more resistant to abrasion than open structures. Tighter and more compact fabrics, such as fabrics woven with plain weave, are less prone to pilling, while longer yarn floats in weave structure and lower overall density increases the possibility of pilling. That is because with tightly constructed fabrics the fibres cannot disconnect that easily from the fabric. However, the tightness and density affect the drapeability and the hand of the fabric, therefore one should consider the end-use and its requirements.

Also, one must consider that garments and other products cut from woven fabrics often produce cut waste, though with efficient patterning the cut waste can be minimised or eliminated.

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Assignment: group work

Analyse woven fabrics used in different apparel product categories. Working in groups of 3–4 students photograph and analyse woven fabrics within different product categories that you can find from your own wardrobe and from local clothing stores – at least 6 different products per group.

- Examine the construction of the different woven fabrics; which types of weaves can be found (you may also draw the weaves) and what are the most common weaves in the product category?
- What would be the fabric trade names of those used fabrics?
- What are the main characteristics of those woven fabrics? E.g., fabric hand, drapeability, cover (a degree of opaqueness), thickness/fabric weight
  Fabric hand refers to a consumer's instinct to use the sense of touch when choosing a fabric; to describe and assess the fabric quality and its suitability for a specific and use. The way that the fabric feels, a tactile sensation, is described as its handle or 'fabric hand'. – quote from Salolainen, M. Interwoven, 2022, page 35.
- In your own thoughts, what do you think about the durability and longevity of that fabric choice compared to the use of the apparel?

Create a digital presentation with several pictures of each product (also close-up pictures of the woven structures) and written notes about the product information (possible brand, material composition, care instructions) and the analysis of the woven fabric and its properties.

6 product categories
- Shirts and blouses
- Trousers (indoor)
- Dresses and skirts
- Coats and jackets
- Outdoor wear
- Scarves and hats

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Visit the project website to see all the intellectual outputs of the project.

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