

WEAVING TECHNOLOGY II

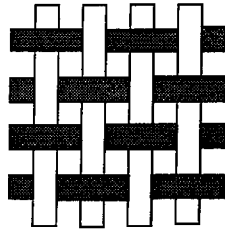
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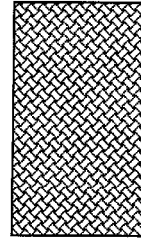
Introduction

- Fabrics are textile surfaces. These structures are extremely long in comparison with their thickness.
- There are basically 3 methods in fabric manufacture:
 1. Weaving
 2. Knitting
 3. Nonwoven fabric manufacture (felt making)
- The yarn is used to produce fabrics by either weaving or knitting.
- An alternative method of producing a fabric from fibers, without making a yarn is that of felt making.
- Fabrics can be produced by one of those methods or by a combination of them.

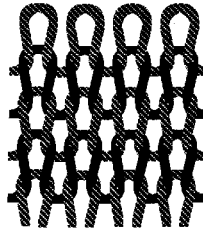
Samples for different fabric structures



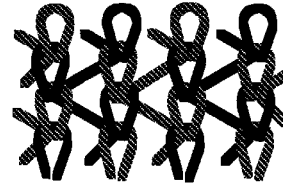
a. woven



b. braided



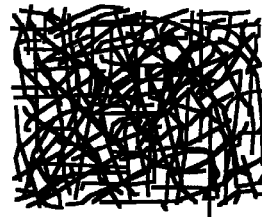
c. weft knit



d. warp knit



e. tufted



f. nonwoven

Schematics of major fabric types

Handbook of Weaving
Sabit Adanur

End-use Fields of Woven Fabrics

- Weaving and knitting are the two most common processes of making cloth.
- Of these two processes, weaving is the most common method, although new and improved knitting machines make cloth quickly, satisfactorily, and with attractive patterns. The majority of the fabric production is based on the woven fabrics.
- Woven fabrics are manufactured for many end-use purposes:
 1. apparel fabrics for clothing/garmenting, i.e., suits, dresses, shirts, coats, sportswear etc.
 2. household textiles & furnishings, i.e., curtains, tablecloths, bed sheets, towels, upholstery and tapestry fabrics, carpets, etc.,
 3. industrial and technical fabrics, i.e., transmission belts, safety belts, sail cloths, sack cloth, tent cloth, geotextiles for buildings.

Exclusive ladies' and men's woolen and worsted apparel fabrics. Especially weavers processing yarns of low breaking strength and high cost like cashmere, alpaca, mohair and silk/wool blends, need a gentle handling of these yarns during filling insertion. The waste saving facilitated by the MotoEco® is essential for the cost effective production of highest fabric quality.

Alta moda fabrics for neckties, women's wear, tapestry and upholstery goods from silk. These fabrics illustrate the almost unlimited patterning potential of DORNIER weaving machines.

All kinds of industrial fabrics from the finest filter materials to air bags - requiring zero defect weaving - through to glass roving. Specially designed and engineered solutions are available for this very diversified range of products.

High quality fabrics with dobby styles up to 28 harness frames for ladies and gents apparel fabrics from cotton and synthetics with the possibility of multiple filling insertion.

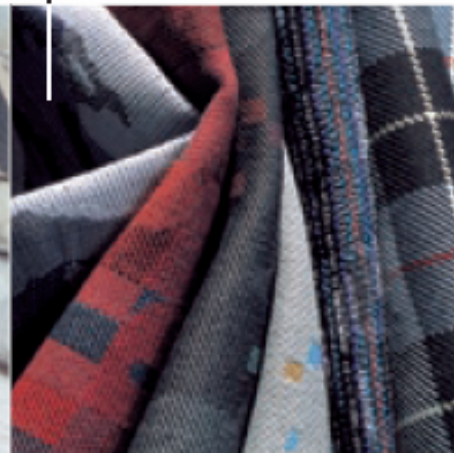


All kinds of industrial fabrics from medium-heavy coating materials through heavy awning fabrics to air bags - requiring zero defect weaving. Specially designed and engineered solutions are available for this very diversified range of fabric production.

High rate of filling insertion, the waste saving MotoEco[®] system as well as quality assurance through the Automatic Start-mark Prevention ASP are important arguments for the production of all kinds of mattress ticking.

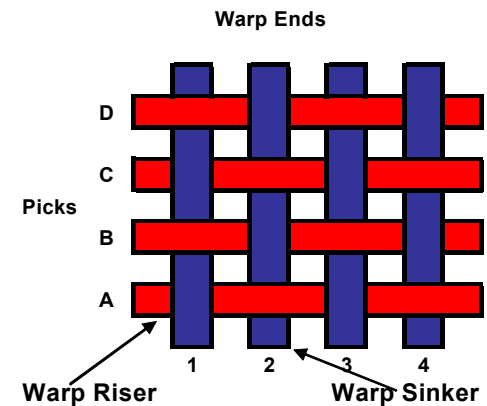
Modern shirting fabrics from cotton and cotton blends and also apparel fabrics from wool and wool blends. Also in these cases DORNIER air-jets with high productivity, low spare parts consumption and excellent fabric quality offer an economic alternative to negative tape rapier weaving machines.

Automotive and residential upholstery fabrics – woven with 8 filling colors utilizing dobbies up to 16 harness frames, or Jacquard machines with up to 10,000 hooks on the DORNIER air-jet weaving machine, type AS.



Weaving and Woven Fabrics

- Weaving is the process of interlacing two sets of yarns at right angles.
- The threads which lie along the length of the fabric are termed **warp threads**, while those which lie across the width are termed **weft** threads.
- More technical names for these same threads are **ends** and **picks** respectively.
- Weft threads are frequently referred to as **filling**.



Weaving and Woven Fabrics

- The weaving or interlacing of warp and weft threads is accomplished with a machine which is known the world over as **loom**.
- The loom may be a **hand loom** or a **power loom**.
- The power loom is also referred to as the **weaving machine**.

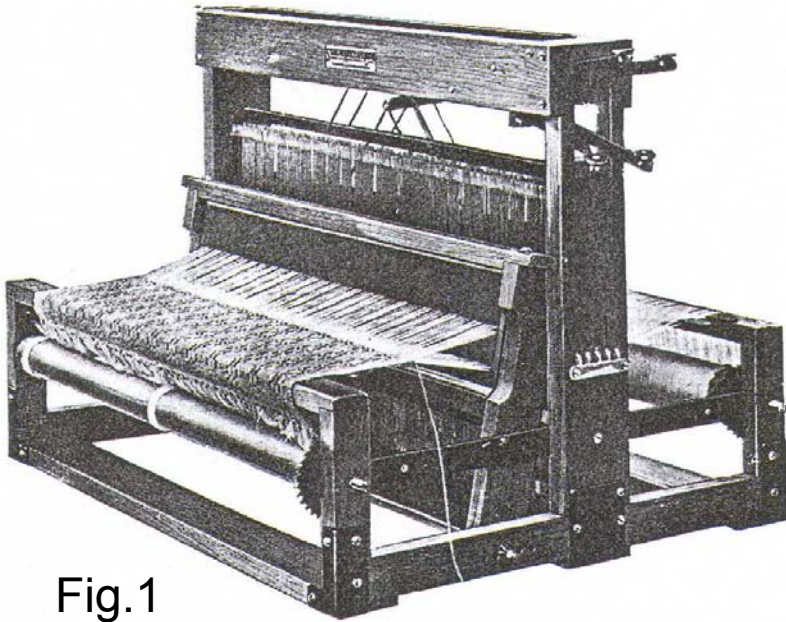


Fig.1



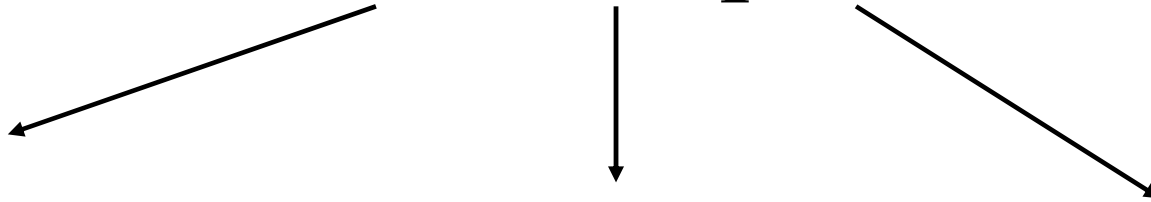


A rapier weaving machine

All woven cloth is made on some sort of loom. For most of the production, power looms have replaced hand looms, taking weaving from the home to the factory.



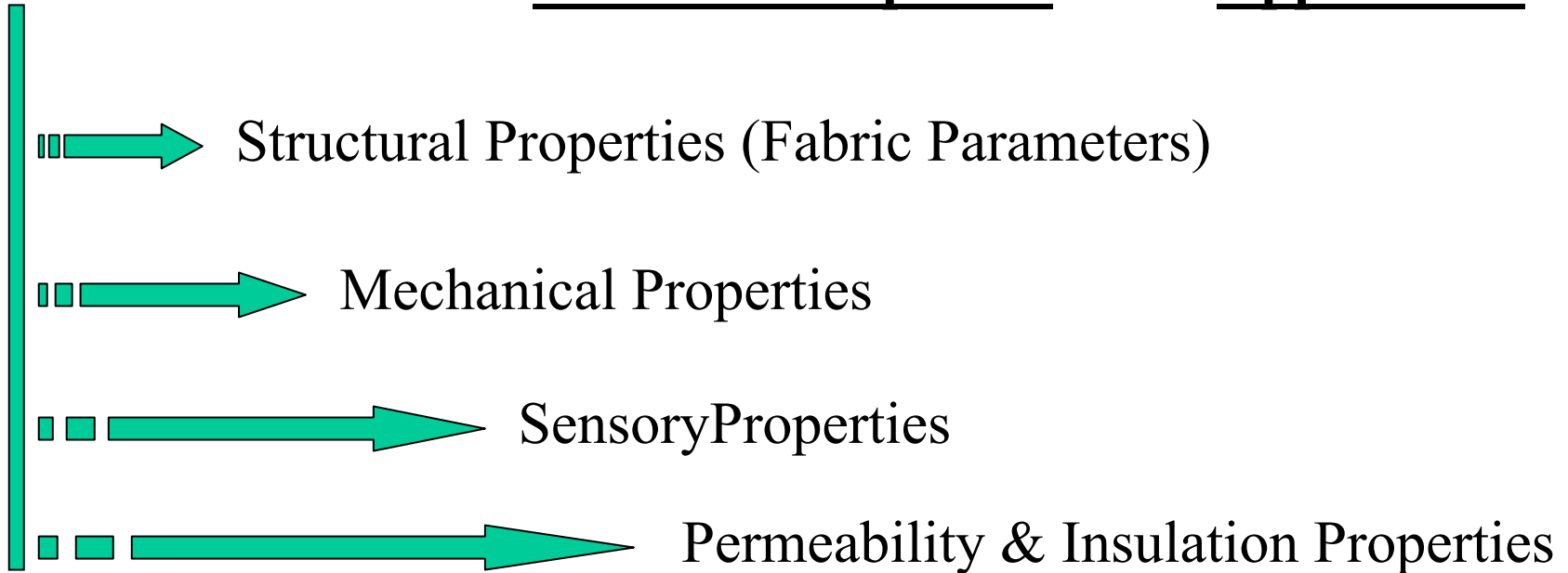
Fabric Properties



Physical Properties

Chemical Properties

Appearance



Chemical Properties

- Chemical properties are highly correlated with the fiber properties.
 - Composition of fiber,
 - Chemical stability,
 - The effect of heat, moisture, acids, alkalis, solvents and other chemicals on fibers,
 - The affinity of the fiber for dyestuffs,
 - Moisture holding ability,
 - Burning behavior, etc.

Structural Properties – Fabric Parameters

1. Warp and weft densities
2. Warp and weft yarn counts
3. Weave
4. Crimp
5. Weight
6. Thickness
7. Cover
8. Fabric width and piece length

Warp and Weft Densities

- **Warp density**

Number of warp ends per unit length of fabric - spacing between warp threads;

Units: ends per cm (e.p.c.) or ends per inch (e.p.i.);

Determined by reed number and denting

- **Weft density**

Number of picks per unit length of fabric - spacing between weft threads

Units: picks per cm (p.p.c) or picks per inch (p.p.i.);

Determined by the rate of fabric take up during weaving.

- **Count of Cloth**

End Density X Pick Density (X is not multiplication sign)

Count of Cloth

- The closeness or looseness of the weave is measured by the count of the cloth. This is determined by the number of picks and ends (filling and warps) to the square inch.
- If the count of the cloth is 80 warps (ends) and 80 fillings (picks) to the inch, the count is expressed as 80 x 80, or 80 square.
- If there are 60 warps and 50 fillings to the inch, the count is expressed as 60 x 50 Number of picks per unit length of fabric - spacing between weft threads.
- The count of surgical gauze is approximately 28 x 24. In comparison of the two counts, a 96 x 88 cloth is considered the higher-count cloth because it has more ends and picks (warps and fillings) to the square inch than has surgical gauze.

Balance of Cloth

- The proportion of warp yarns to filling yarns (picks) is called the balance of a cloth.
- If the number of warps and the number of fillings to the inch are nearly the same (not more than ten yarns difference), a cloth is said to have good balance.
- The gingham (a stripe cotton cloth) whose count is 60 x 50 would be considered a fair-balanced cloth.
- Gauze with a count of 28 x 24 also has a good balance.
- A sheeting with 61 warp ends and 40 picks (61 x 40) has poor balance because there are too many ends and too few picks.
- Even though the sheeting is woven in the plain weave, ordinarily a strong construction, there are so few picks that the ends will slip over them very easily, causing a shredded effect.
- Good balance is very important in cloths that have to stand hard wear and many washings. Sheets, pillow slips, and towels for glasses and dishes, for instance, should have good balance.

- **Yarn Count (Fineness or coarseness of yarns)**

It is very difficult to determine the yarn diameter by a direct measurement and it is more common to express the coarseness of the yarn in terms of its weight per unit length, hence in terms of the yarn count.

$$1 \text{ Nm} = 1,693 \text{ Ne} = (1000/\text{tex}) = (9000/\text{denier})$$

English Units

$$1 \text{ inch} = 2,54 \text{ cm} ; 1 \text{ yard} = 0,91 \text{ m}$$

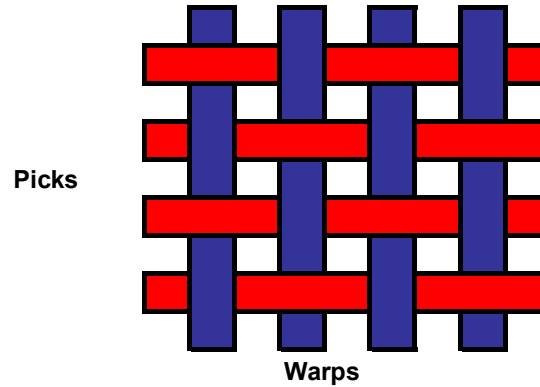
$$1 \text{ libre(pound)} = 0,453 \text{ kg} ; 1 \text{ ons} = 28,34 \text{ g}$$

Weave

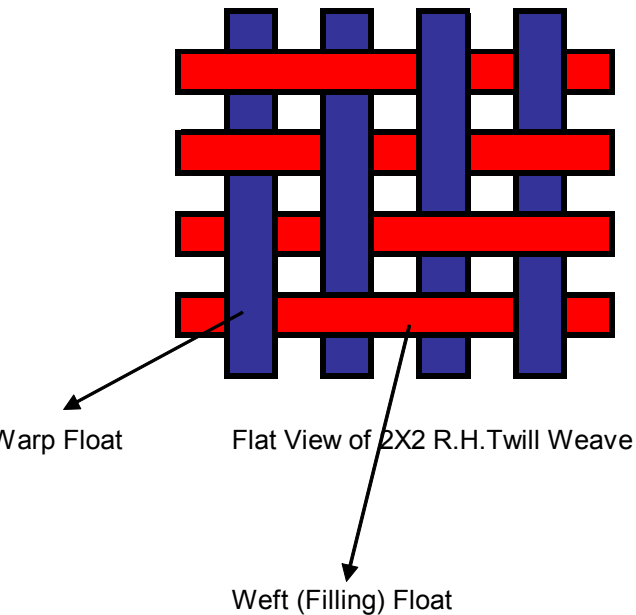
- The fabric **weave** or design is the manner in which the warp and weft threads are interlaced.
- In practice, the weaves of most fabrics are designed in a such way that the **weave pattern** of a small area is repeated over the whole area of the fabric. The weave pattern within the small area, called the **weave repeat**, is usually referred to as weave.
- Simple weaves with small repeats are by far the most common.
- There are important differences between these three basic weaves, namely, **plain weave**, **twill** and **satın**.

Fabric Parameters: Weave

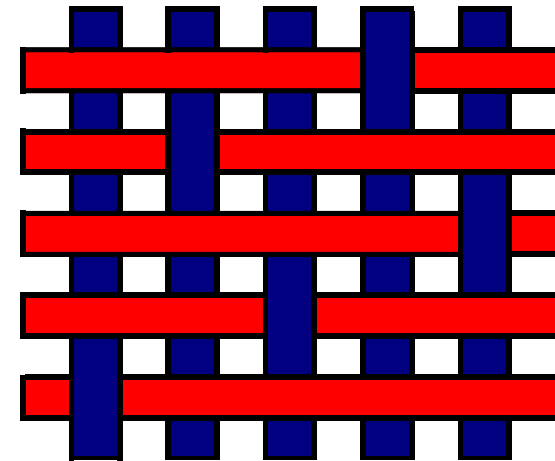
PLAIN WEAVE



TWILL WEAVE

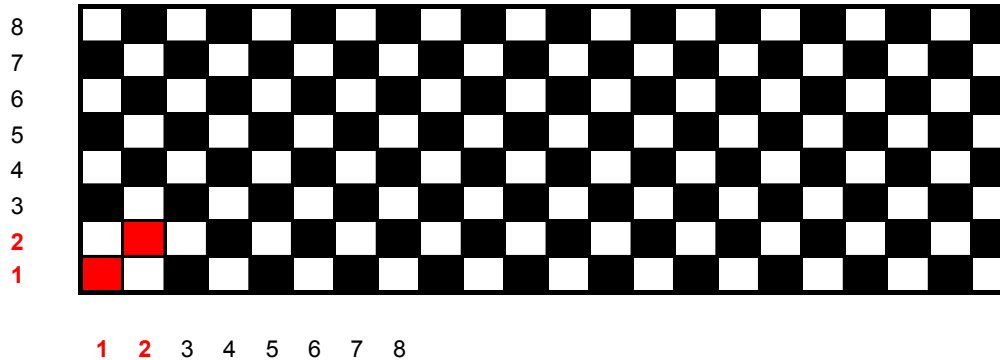


SATIN & SATEEN WEAVES

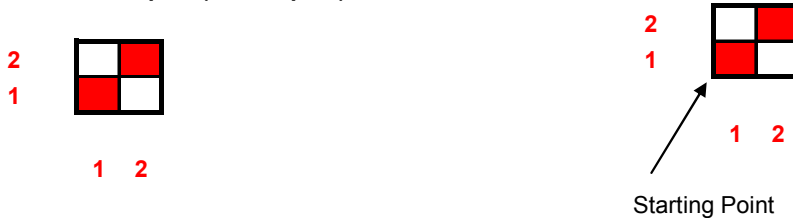


Point Paper Design

Weave Representation on Design Paper



Weave Report (One Repeat)

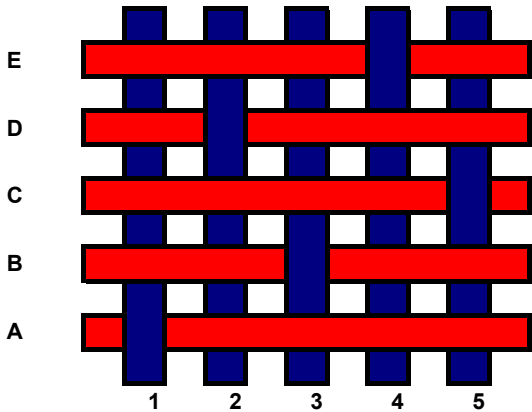


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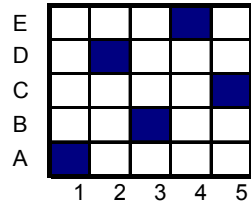
Point Paper Design

Thread diagrams

SATIN & SATEEN WEAVES



Squared paper design of 5-end sateen



Ends

1 2 3 4

Picks

4
3
2
1

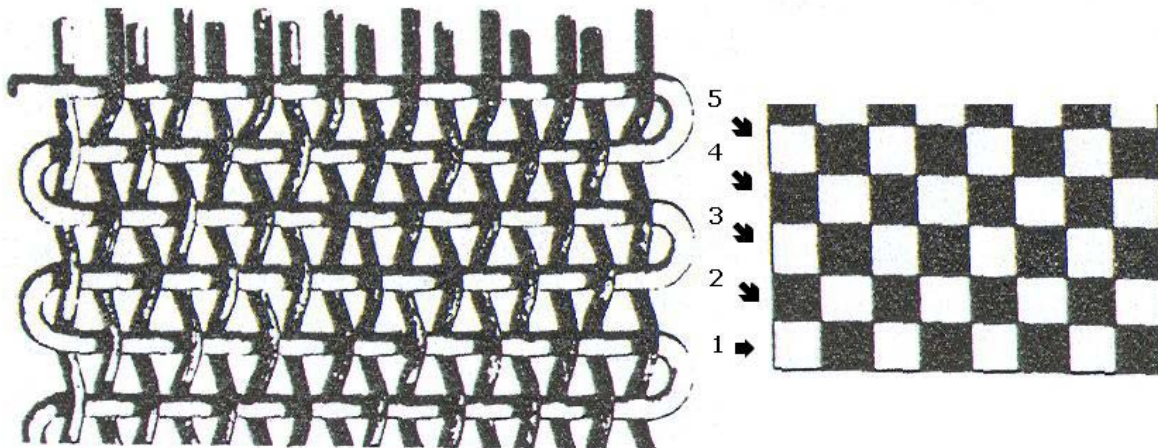
WEFT CROSS SECTION

Cross sections of plain weave

- The use of **thread diagrams** and **cross sections** are the other effective methods of representation.

Plain Weave

- The **plain fabric** comprises a high percentage (**approximately 40%**) of the total production of woven fabrics.
- In this simplest weave, considering the starting point of the weave repeat, the first filling is passed over one warp thread and under the next, regarding the figures given below. The second filling goes under the first warp and then passes over the second end.



Cloths Made in the Plain Weave

- It has the highest number of interlacing as compared with other weaves and therefore it produces the **firmest** fabrics.
- Plain weave is sometimes called **cotton, taffeta, or tabby weave**. Some of the most **durable** fabrics are made in this construction.
- The **weaving process** is comparatively **inexpensive** because the design is so simple.
- The plain weave cloths can be cleaned easily, and when firm and closely woven, they wear well.

Cloths Made in the Plain Weave

- A partial list of plain weave fabrics are as follows:
 1. **Cottons.** Gingham, percale, voile, plissé crepe, batiste, calico, chambray, cheese-cloth, chintz, crash, cretonne, muslin sheeting, cambric, lawn, organdy, shantung, unbleached muslin, scrim, buckram, canvas, flannelette.
 2. **Linens.** Handkerchief linen, art linen, rash toweling, cambric, dress linen.
 3. **Nylons and other man-made fibered fabrics.** Organdy, lingerie crepe, shantung, taffeta, shirting (many of these constructions are also made in blends with natural yarns and with other man-made fibered yarns).
 4. **Rayons and/or acetates.** Taffeta, georgette, flat crepe, seersucker, ninon, organdy, voile, rough crepe, chiffon.
 5. **Silks.** Taffeta, organza, voile, Canton crepe, crepe de Chine, flat crepe, chiffon, shantung, silk shirting, broad cloth, China silk.
 6. **Wools.** Homespun, challis, crepe, batiste, some tweeds, voile.
 7. **Blend and mixtures of the various fibers.**

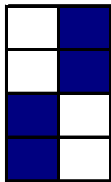
Variations in the Plain Weave to Produce Different Effects

The plain weave without any variation, as is found in sheeting and unbleached muslin, does not make a particularly interesting fabric. Several methods can be used to make a plain-weave fabric more attractive.

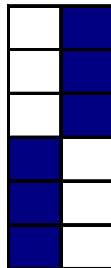
- Rib Variation:

1. The first is to produce a ribbed or corded effect by using **rib weaves** which are the derivatives of the plain weave.

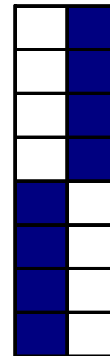
WARP RIB WEAVES



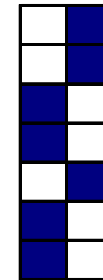
2x2 Warp Rib



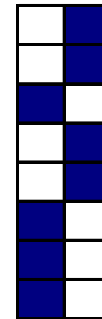
3x3 Warp Rib



4x4 Warp Rib

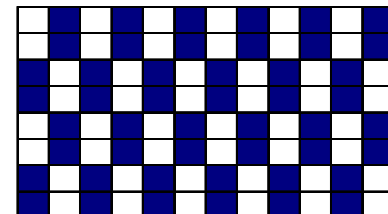


2x1, 2x2 Warp Rib



3x2, 1x2 Warp Rib

warp ribs repeat on 2 ends

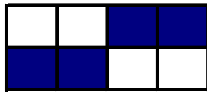


Variations in the Plain Weave to Produce Different Effects

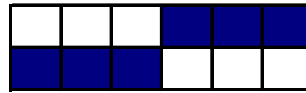
- Rib Variation:

WEFT RIB WEAVES

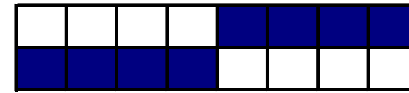
weft ribs repeat on 2 picks



2X2 Weft Rib



3X3 Weft Rib



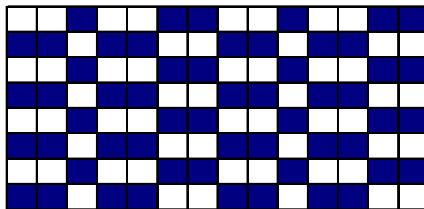
4x4 Weft Rib



2X1, 2x2 Weft Rib



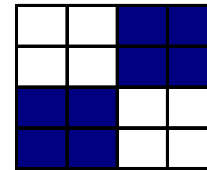
3X2, 3x1 Weft Rib



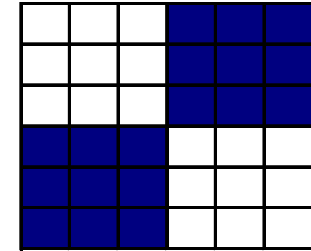
Variations in the Plain Weave to Produce Different Effects

- Basket Variation:

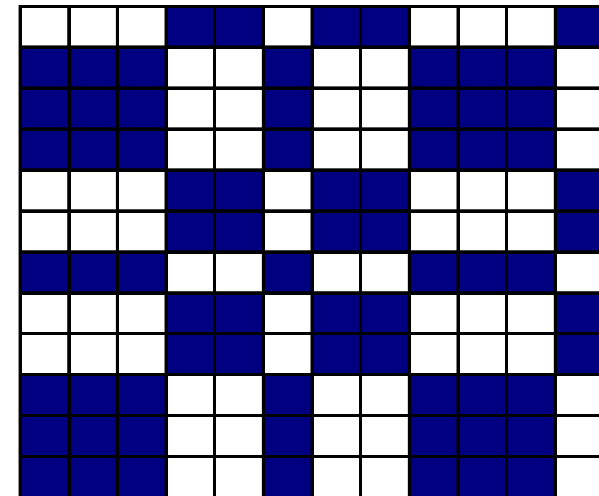
- The basket variation of the plain weave is interesting from the design point of view, but it is not so durable as the average rib variation.
- One or more filling yarns are passed alternately over and under two or more warp yarns.
- In the figure given below, two fillings pass alternately over two warps and filling yarns are the same size.
- A 4 x 4 or 8 x 8 basket weave is found in monk's cloth.



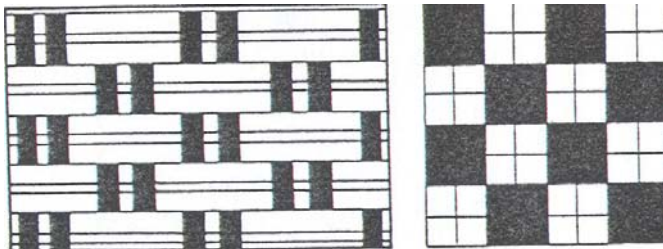
2X2 Basket Weave



3X3 Basket Weave

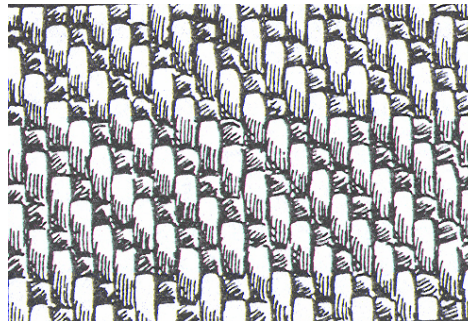


3x2, 1x2, 2x1 Basket Weave

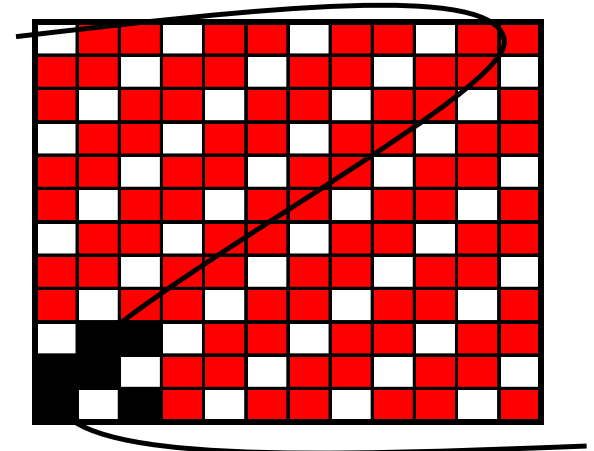


Twill Weave

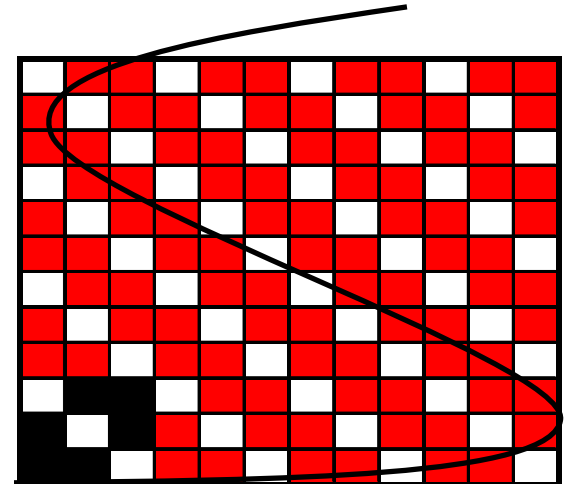
- **Twill** is the most durable of all weaves.
- Twill weave is characterized by diagonal lines running at angles varying between 15°-75°.
- In this weave the filling yarns are interlaced with the warps in such a way as to form diagonal ridges across the fabric.
- If the wales run from upper right to lower left, the weave is called a **right-hand twill (Z twill)**; if the wales run from upper left to lower right, the weave is called a **left-hand twill (S twill)**; if these diagonals, the wales, run both ways in the same cloth, the weave is a **herringbone**.



2 x 1 Twill (Z)

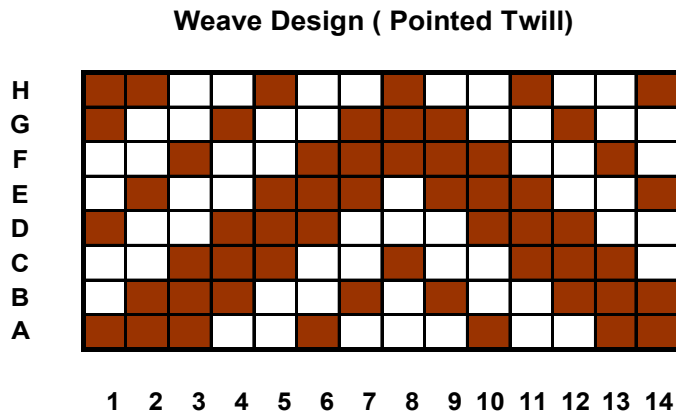


2 x 1 Twill (S)

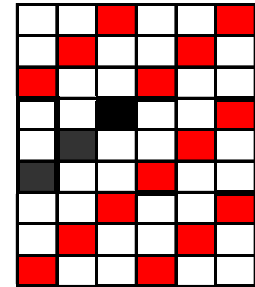


Twill Weave

Herringbone



1 x 2 Twill



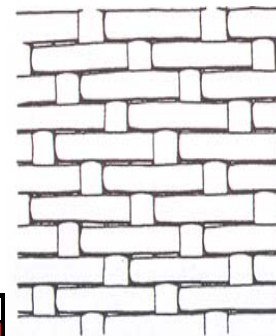
- Types of twill: **warp face twill (uneven twill)**, **weft face twill (uneven twill)**, **balanced twill (even twill)**, **45° twill**, **steep twill**, **reclining twill**.
- Comparing the plain weave, heavier fabrics can be produced with the twill weaves and the fabric has a great extensibility in the diagonal direction, that is why the twill fabrics are suitable for outwear.
- The twill weave may also be called the **serge** or **diagonal weave**.

Cloths in Twill Weave

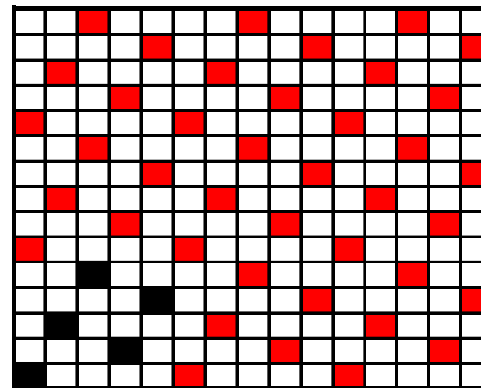
- Cloths made in twill weave may be classified as follows (it will be noticed that the twill is frequently used for cottons and wools):
- **Cottons.** Jean, ticking, drill, Canton flannel, denim, gabardine, covert cloth, khaki, serge.
- **Linens.** Ticking and table and towel drills.
- **Silks.** Twill foulard, serge.
- **Wools.** Serge, worsted cheviot, gabardine, covert, flannel (twill or plain), tweed (twill or plain), unfinished worsted, broadcloth, sharkskin.
- **Rayons, acetates and blends.** Gabardine, foulard, flannel.
- **Polyester.** Suitings such as serge and gabardine.

Satin Weave

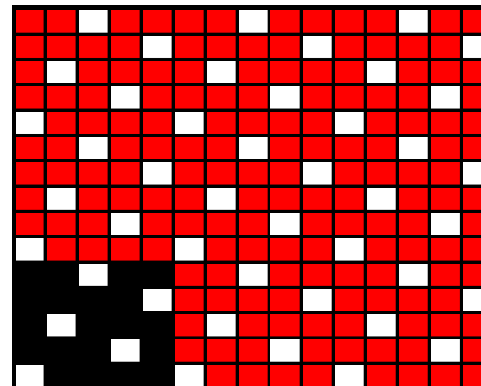
- **Satin** is the third basic weave, in which the interlacing points are arranged in a similar way to twill weaves but without showing the twill line.
- The **satin weave** is a warp face weave and the **sateen weave** is a weft face weave. The satin and sateen fabrics are soft and lustrous structures.
- The satin weave gives great sheen to a fabric and reflects the light better than dull-finished fabrics in plain or twill weave do.
- Materials that are made in the satin weave include antique satin (millions of yards per year), bridal satin, cotton satin, dress satin, satin bengaline, satin crepe, satin faille, slipper satin, and Venetian satin.



5 HARNESS SATEEN



5 HARNESS SATIN



Fabric Parameters

- **Crimp** : Waviness of yarns

$$\%c = [(l_y - l_{fab}) / l_{fab}] \times 100$$

- **Take-up**

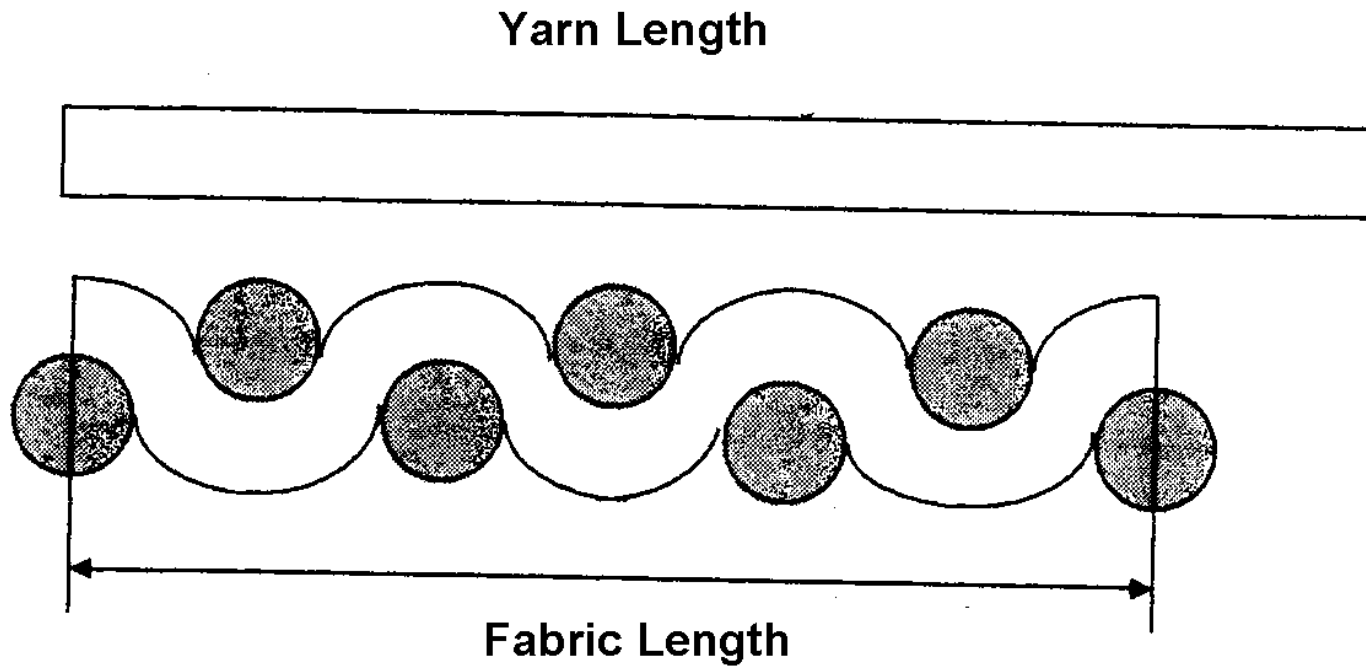
$$\%k = [(l_y - l_{fab}) / l_y] \times 100$$

Crimp

$$\text{Crimp (\%c)} = [(l_y - l_{fab}) / l_{fab}] \times 100$$

Take-up

$$\text{Take-up (\%t)} = [(l_y - l_{fab}) / l_y] \times 100$$



Fabric Weight

- The fabric weight is expressed in grams per square meter (W/m^2) or in grams per meter of the fabric with full width (W/m).
- It is difficult to compare fabrics if the widths are not reasonably similar and for this reason, weight per square meter would be a more rational method because differences in width would not affect comparison.
- The range of weights in woven fabric varies from as little as 15 g per square meter for chiffon to 600 g or more per square meter for heavy coating fabrics.
 - suits- 350 to 500 and g/m^2
 - canvas and sacking cloth may be 1,000 or even 1,500 g/m^2 .
- Basis weight
Used to compare different fabrics.

Related to end-use.

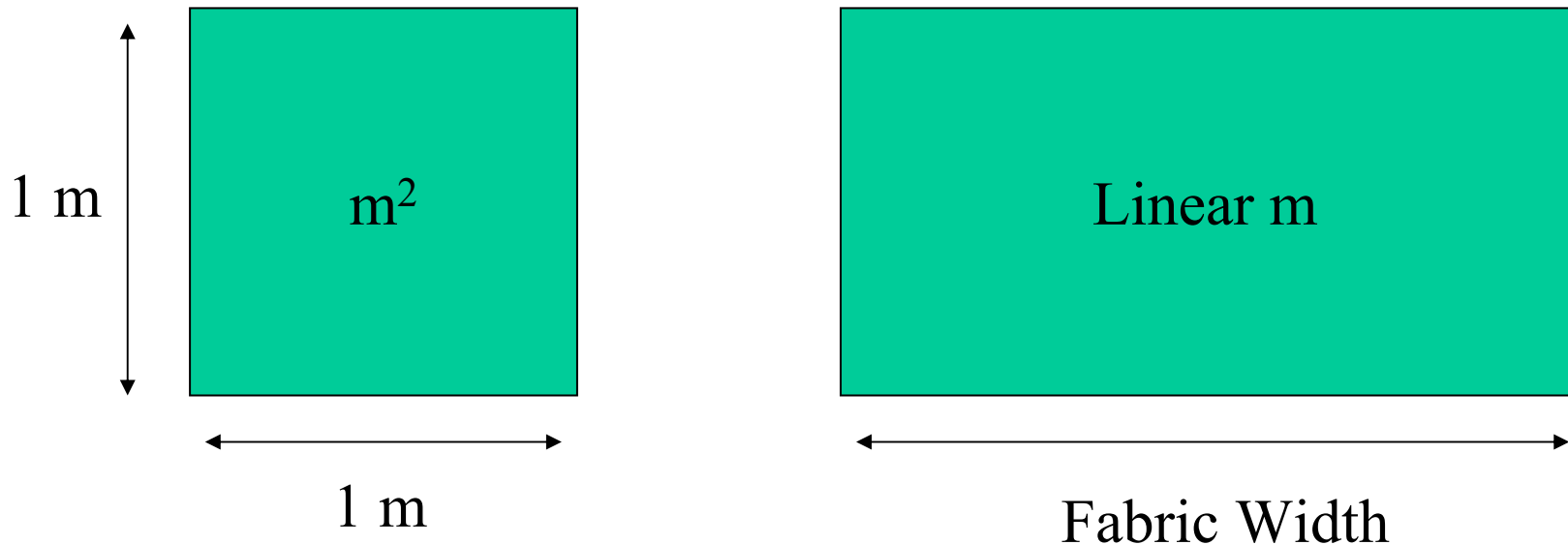
Units: g/m^2 ; oz/yd^2
- Fabric Weight per Linear Unit Length

Used for trade (Buying or Selling).

Units: g/m ; oz/yd

Fabric Weight Calculations

There is a direct and simple quantitative relationship between fabric weight and the other three structural parameters, namely, warp and weft yarn counts, densities and crimps.



Fabric Cover

The **cover** defines the area of 1 cm² of a fabric which is actually covered by warp and weft yarns. It is a useful and practical indication of fabric's permeability to light, air, gasses, liquids and solid particles.

•Fractional Cover Factor

$$c_1 = d_1 / p_1$$

$$c_2 = d_2 / p_2$$

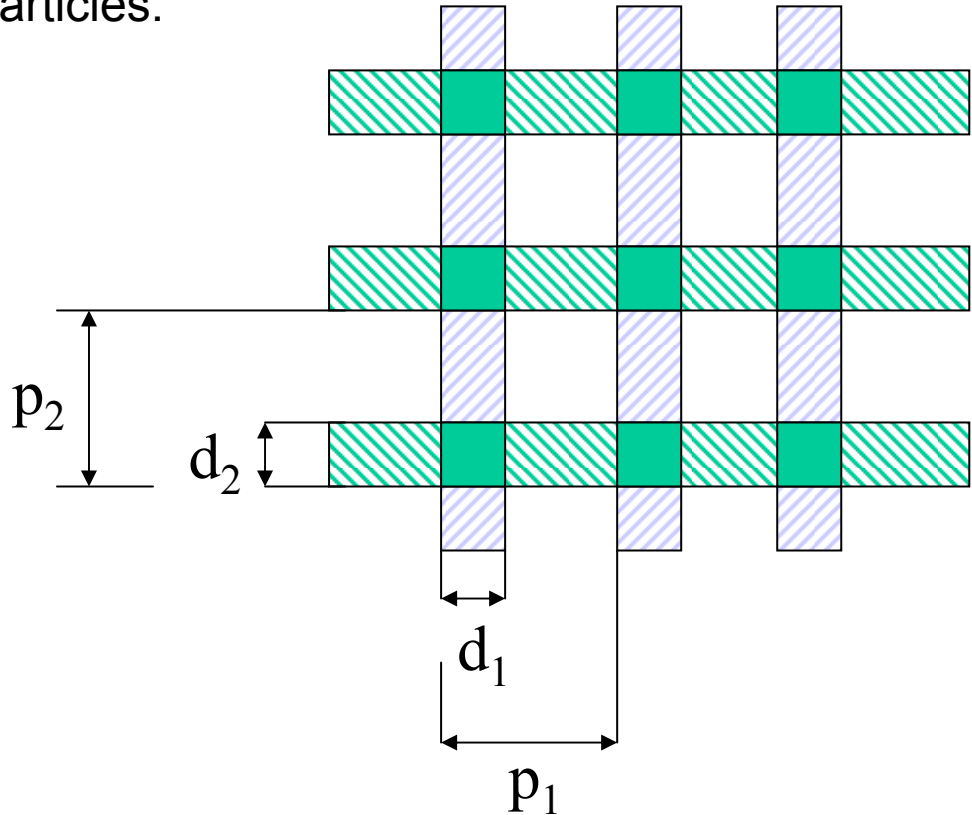
$$c = c_1 + c_2 - c_1 c_2$$

Cover Factor (Pierce)

$$K = n / (Ne)^{1/2}$$

$$K = 28.c$$

$$K = K_1 + K_2 - (K_1 K_2) / 28$$



Characterization of Fabric by its Cover

Fabric Type	C_f	K_f
Open or Loose Construction	25% - 50%	7-14
Regular Construction	50% - 75%	14-21
Close or Tight Construction	75% - 100%	21-28

Significance of Fabric Cover

- Construction of a similar (of same cover) fabric to a cloth with different construction parameters (yarn size, fiber etc.)
- Fabric cover is related to fabric properties (such as passage of air and light). Thus designers can construct fabrics with predetermined properties for certain end use.

Fabric Parameters

Fabric Thickness

Thickness in mm.

- **Fabric Width and Piece Length**

Fabric width is usually expressed in cm.

It varies from 30 cm upwards.

Narrow fabrics like ribbons, tapes and braids are made by a special section of weaving industry.

Certain types of fabrics are associated with specific widths

Shirtings & dress fabrics 90-114 cm etc.

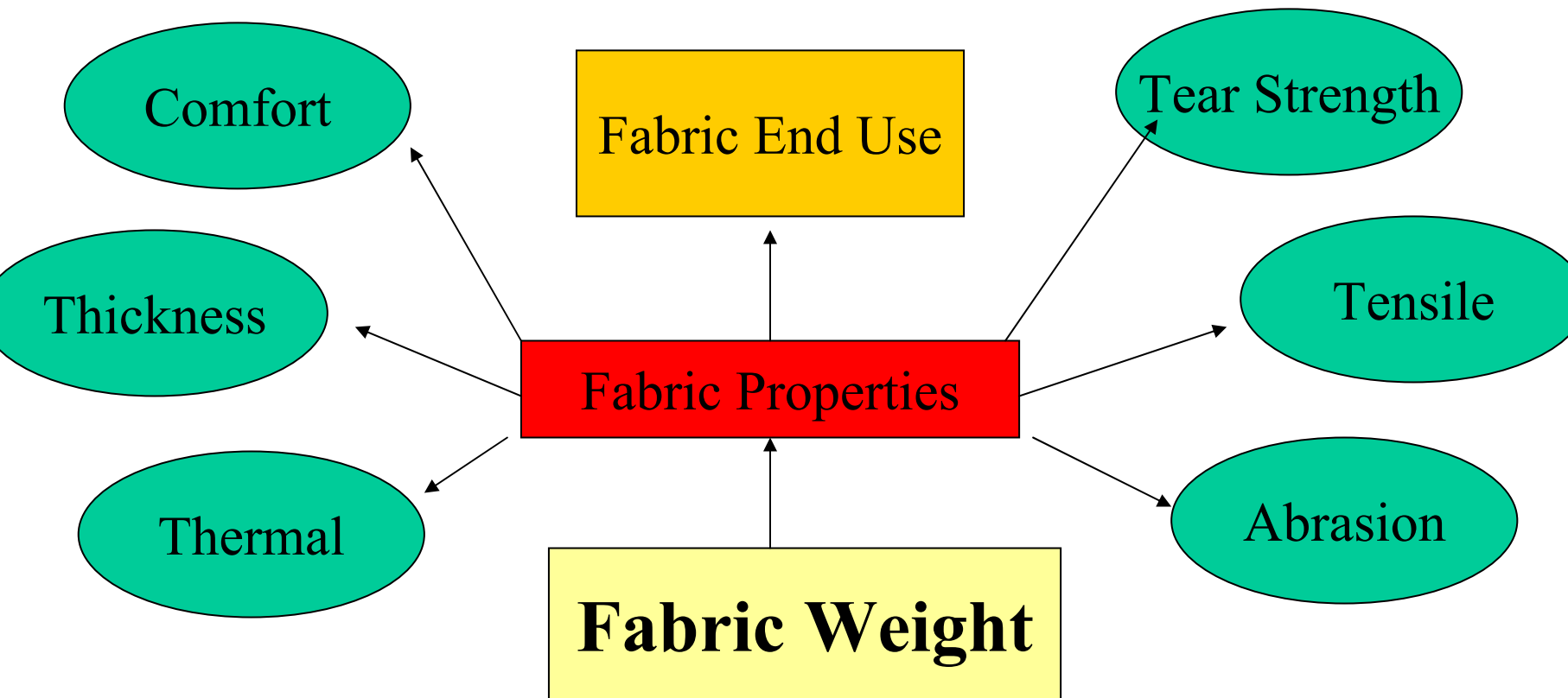
Worsted and other suitings -150 cm

Bed sheetings 2-3 m, etc.

- **Piece Length**

The **piece length** defines the piece of fabric cut to a particular length.

Fabric Parameters



Fabric Weight Affects Fabric Properties / End Use

Some of the Mechanical Properties

- **Tensile Strength-** It implies the behavior of the fabric under different loads applied.
- **Extensibility-** It is the ability of the fabric to extend under load.
- **Tear Strength-** A hole has been made in the fabric because it has been pulled sharply.
- **Abrasion Resistance-** Resistance of the fabric against the surface friction.
- **Crease Resistance-** Creases are irregular lines that appear on cloth when it has been crushed.
- **Pilling Resistance-** Hairs on the surface of a fabric tend to collect into little balls (pills) and if the fibers are strong, these balls do not break off; this spoils the appearance of the fabric.

Sensory Properties

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graph TD; A[Sensory Properties] --> B[Drape]; A --> C[Handle];
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Drape

The shape or the way in which the fabric hangs down in folds (i.e. curtains hanging way; the appearance of a skirt or the hanging of cloth over the edge of table).

Handle

- 'sum of the total sensations'
- when a textile fabric is handled by touching, flexing of fingers, smoothing, and so on.
- three methods of perception (subjective evaluations):
 - sight only (visual perception),
 - touch only (tactile perception) and sight and touch together.
- the judgment of roughness, smoothness, harshness, pliability, thickness etc.

Permeability & Insulation Properties

Comfort Factors:

- Thermal Conductivity
- Thermal Protection/ Insulation (in cold regions)
- Water-vapor Resistance
- Air Permeability
- Water Permeability
- Wind resistance

Some Others:

- Filtered fabrics
- Electrical conductivity
- Bullet proof fabrics, etc.

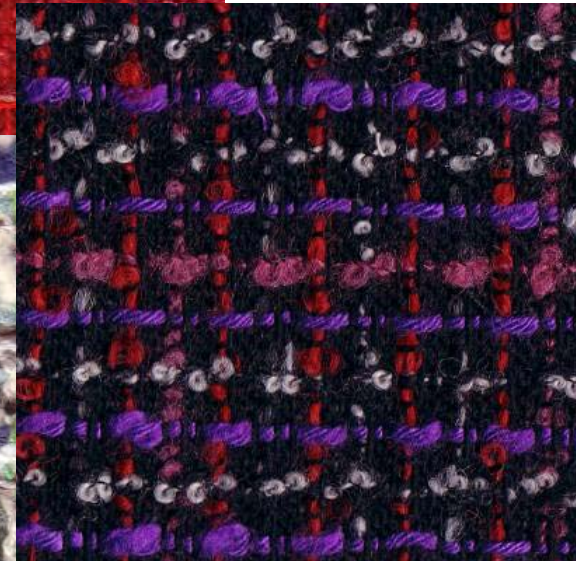
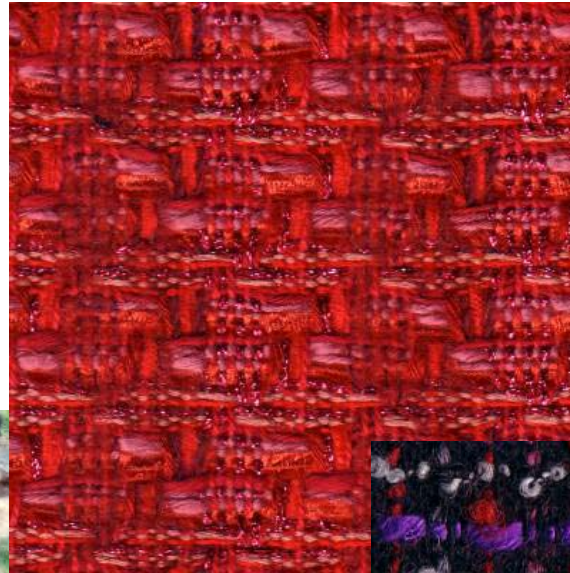
Appearance

- Surface characteristics (luster, opaque)
- Texture (i.e., the visual & tactile perceptions for velvets, silk fabrics)
- Ornamentation
 - **Using of colored yarn** - When colored yarns are used in one direction, color stripes are produced along the length or across the width of the fabric. When colored yarns are used in warp and weft direction together a check effect is produced. These arrangements are commonly used in fabrics with plain weave or 2/2 twill.
 - **Changing the yarn count**- Stripes and check effects can be produced by using different yarn counts in one or both directions. For instance, rib effects can be produced by using different yarn counts in plain weave fabrics.
 - **Changing the yarn twist**- Using combinations of different twist levels and twist directions along the length of the fabric or across the width (or both), different effects can be produced in the fabric. Also different amounts of twist produce different shrinkage (contraction) characteristics in different parts of the fabric and so change the appearance.

Appearance

- **Combining different weaves-** There are many ways to combine different weaves. Stripe, check effects and figured fabrics can be produced.
- **Different finishing techniques-** Treatments such as dyeing, printing, mercerizing or coating can change the surface characteristics of the fabrics.
- **Any combination of the above.**

Typical fashion fabric tweeds currently in fashion.



Flannel shirtings





Chambrays



Gingham



Striped shirt



Crepe



Tweed

