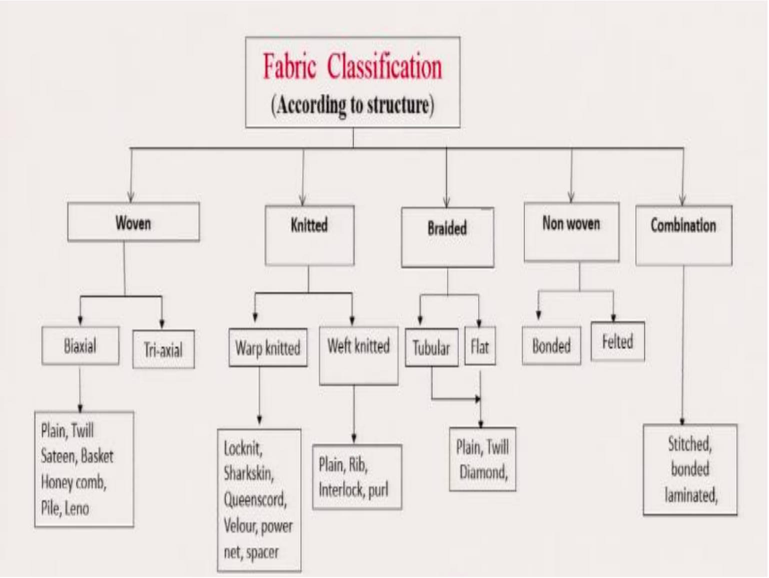
Textile Product Design and Development
Prof. R. Chattopadhyay
Department of Textile and Fibre Engineering
Indian Institute of Technology - Delhi

Lecture – 10
Significant of Fabric Properties in Design

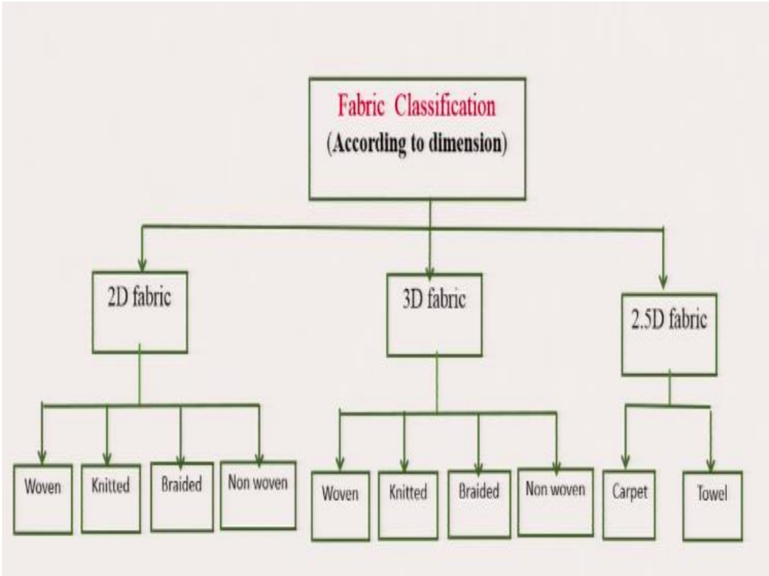
We will discuss the significance of fabric properties in design. Most of us are familiar with fabric production techniques and fabric properties. We will now discuss how these properties are relevant to the design point of view and start with the classification of fabrics.

(Refer Slide Time: 01:03)



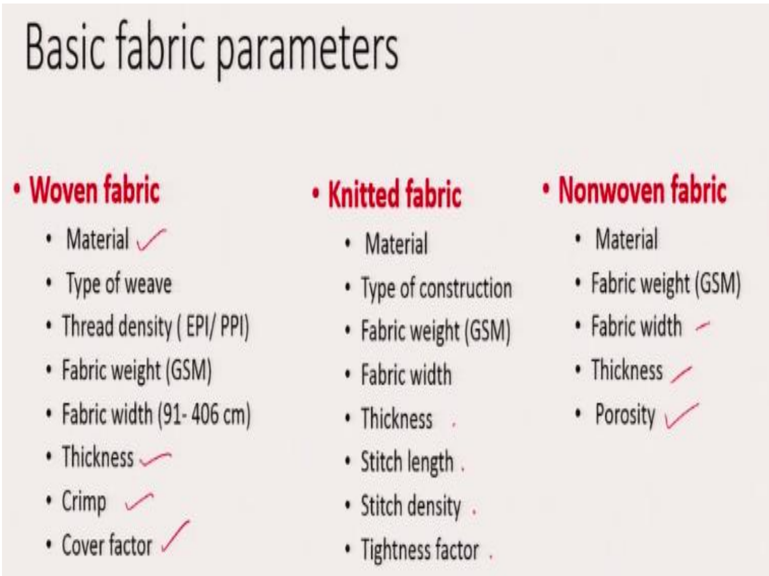
According to the structure, fabrics can be classified as woven, knitted, braided, nonwoven, and combination. In woven fabrics, it has both biaxial and triaxial fabrics. Knitted fabrics can be classified into warp-knitted and weft-knitted fabrics. Braided fabrics are also classified into tubular braid and flat braid. Nonwoven fabrics have bonded and felted types; in combination, they have stitched, bonded and laminated fabrics. Various fabrics are available, and when designing a specific product, knowledge about the fabric properties must be understood so that selection criteria will meet the requirements.

(Refer Slide Time: 02:72)



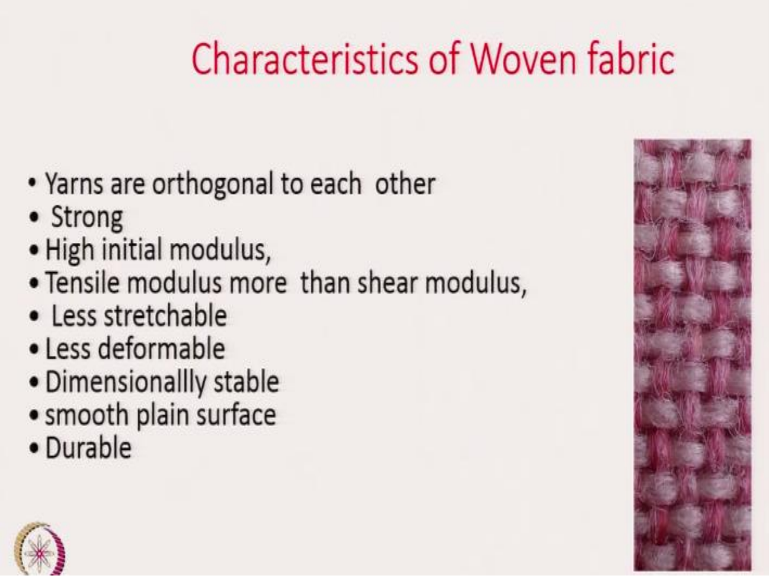
There is another classification of fabrics based on the dimensions. They are 2D fabrics, 3D fabrics and 2.5D fabrics. Woven, knitted, nonwoven and braided fabrics come under 2D and 3D fabrics. Carpets and towels come under 2.5D fabrics. These are the two ways in which fabrics are classified.

(Refer Slide Time: 03:06)



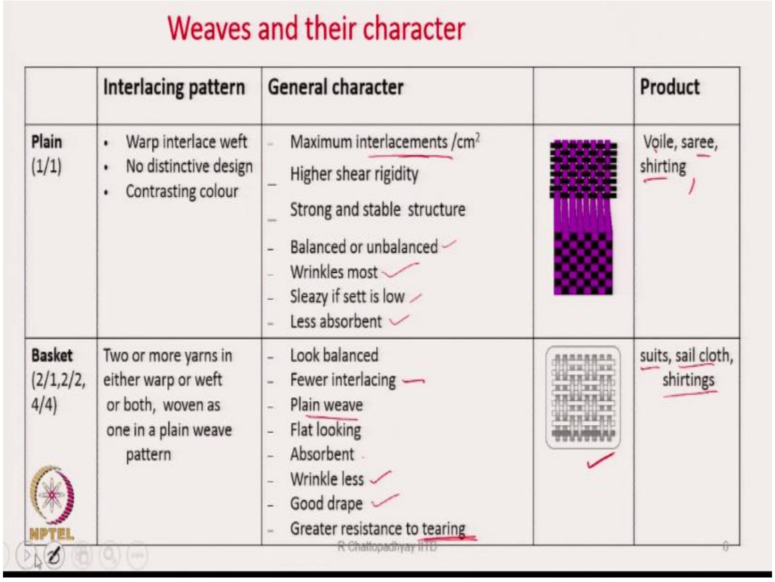
What are the basic parameters of a fabric? The significant basic parameters of fabrics are listed in the slide. For woven fabric, the first important parameter is the type of material, i.e., cotton, polyester or silk. This is followed by the kind of weave, thread density (EPI and PPI), fabric weight or areal density (GSM), fabric width, thickness, crimp and cover factor. These are the basic fabric parameters; these parameters should express the fabric details during the design process. So, these are all part of the detailed design. Similarly, for knitted fabrics, material, type of construction, and fabric weight, i.e., areal density, width, thickness, stitch length, stitch density, and tightness factor are considered, and for nonwoven fabrics, it is again material, fabric weight, fabric width, thickness, and porosity.

(Refer Slide Time: 05:00)



Next is to understand the essential characteristics of woven fabrics. There is a diagrammatic representation on the right-hand side, which depicts the structure of plain-woven fabrics. Generally, in woven fabrics, two sets of yarns are orthogonal to each other. Woven fabrics are usually very strong and have high initial modulus. Their tensile modulus is more than the shear modulus. They are less stretchable and less deformable. They are dimensionally stable and have a smooth, plain surface. It is durable compared to knitted and nonwoven fabrics.

(Refer Slide Time: 06:39)



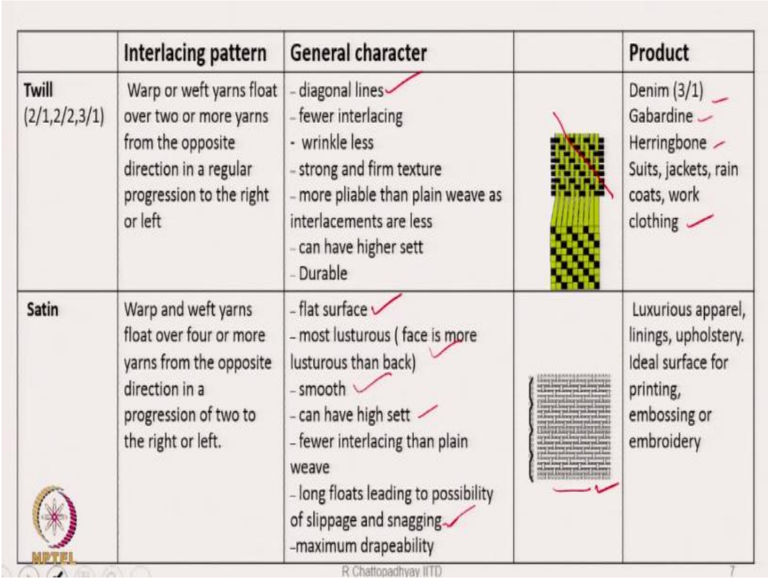
Weaves and their character

	Interlacing pattern	General character		Product
Plain (1/1)	• Warp interlace weft • No distinctive design • Contrasting colour	- Maximum interlacements /cm² - Higher shear rigidity - Strong and stable structure - Balanced or unbalanced - Wrinkles most - Sleazy if sett is low - Less absorbent		Voile, saree, shirting
Basket (2/1,2/2, 4/4)	Two or more yarns in either warp or weft or both, woven as one in a plain weave pattern	- Look balanced - Fewer interlacing - Plain weave - Flat looking - Absorbent - Wrinkle less - Good drape - Greater resistance to tearing		suits, sail cloth, shirtings

Different types of weave architectures are illustrated in the table. Different types of fabric architectures can be created with the various interlacement patterns. It depends on the way of interlacement of two threads. Plain weaves have one warp yarn interlaced with one weft of yarn. The general characteristics of the fabrics are stated in the table. Plain woven fabrics have a maximum number of interlacements. It has higher shear rigidity, a strong and stable structure, and is balanced or unbalanced. It wrinkled the most. It is sleazy if the sett is low. It is less absorbent for liquid absorption. Typical examples of such fabrics are voile, saree and shirting, where plain woven fabric is used.

Another kind of weave architecture is basket weave, and diagrammatic representation is given. There are two or more yarns in either warp or weft direction or in both directions, woven as one in a plain weave pattern. The interlacement pattern is plain weave, and structural characteristics are balanced. The interlacement pattern is less than that of a plain weave. It looks flat and more absorbent. They are wrinkleless and have good drapability. It has high resistance to tearing. A basket weave is better for a fabric with better tear resistance than a plain weave. Typical applications are suits, sailcloth and shirting.

(Refer Slide Time: 09:11)

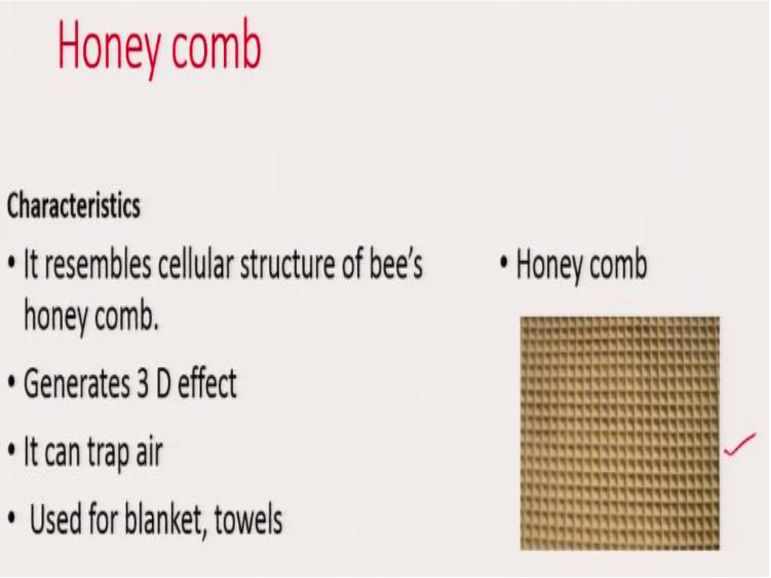


	Interlacing pattern	General character		Product
Twill (2/1,2/2,3/1)	Warp or weft yarns float over two or more yarns from the opposite direction in a regular progression to the right or left	- diagonal lines - fewer interlacing - wrinkle less - strong and firm texture - more pliable than plain weave as interlacements are less - can have higher sett - Durable		Denim (3/1) Gabardine Herringbone Suits, jackets, rain coats, work clothing
Satin	Warp and weft yarns float over four or more yarns from the opposite direction in a progression of two to the right or left.	- flat surface - most lusturous (face is more lusturous than back) - smooth - can have high sett - fewer interlacing than plain weave - long floats leading to possibility of slippage and snagging -maximum drapeability		Luxurious apparel, linings, upholstery. Ideal surface for printing, embossing or embroidery

The other type of woven fabric architecture is twill weave. Warp or weft yarns float over two or more yarns from opposite directions in a regular progression to the right or left. Examples are 1/1 twill, 2/2 twill, 3/1 twill, etc., the twill pattern creates diagonal lines. They have a few interlacement points. It is wrinkleless, and it has strong and firm structures. They are more pliable and have higher sett. They are also durable. Typical products are denim, gabardine, herringbone, suits, and coats.

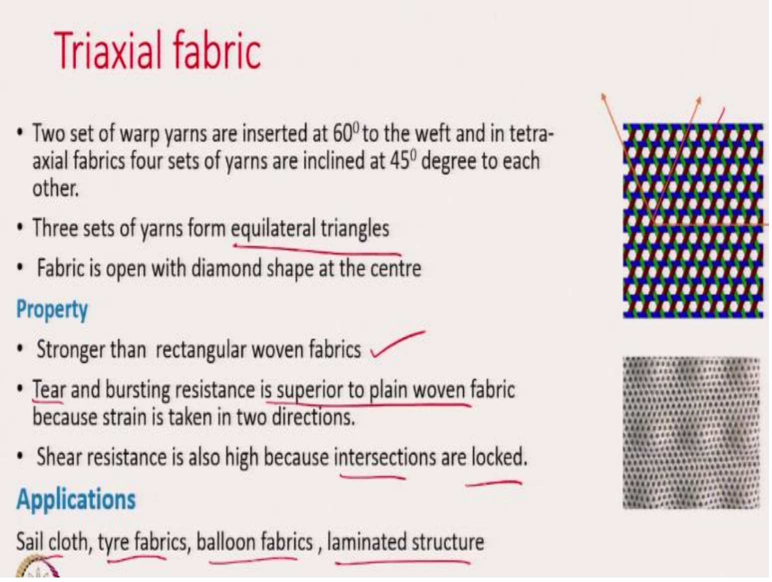
Next is the satin weave. They have warp and weft yarns that float over four or more yarns from the opposite direction. They have long floats which means that the total number of interlacements or interlacements per unit area is much less in this weave architecture. It generally creates a flat surface because of long floats. Weft floats are represented in the diagram. As the surface is flatter, it is more lustrous. The fabric is smooth and has a high sett. Long floats lead to the possibility of slippage and snagging. But it gives a luxurious appeal and is generally used for making upholstery.

(Refer Slide Time: 11:06)



The other type of weave is a honeycomb weave. The characteristics of the honeycomb weave are: it resembles the cellular structure of the bee's honeycomb. A typical diagram is illustrated on the slide. It generated a 3D effect. It can trap air and is generally used for making blankets or towels.

(Refer Slide Time: 11:40)



Previously discussed fabric architectures are biaxial, having two sets of yarns, i.e., warp and weft yarns. In triaxial fabrics, there are three sets of yarns involved. The diagram shows it in three different colours: green, blue and red colour yarns. Two sets of warp yarns are inserted at 60 degrees to the weft, and in tetra-axial fabrics, four sets of yarns are inclined at 45 degrees to each other. These three sets of yarn form equilateral triangles, and the fabric is open with a diamond shape at the centre. Hexagonal holes are created between the yarns.

The properties of triaxial fabrics are stronger than those of rectangular woven fabrics. The advantage is that tear and bursting resistance is superior to plain woven fabrics because the strain is taken in two directions. The shear resistance is also very high because intersections are locked. Three yarns pass over each other at every intersection, so every intersection gets locked, making it difficult to shear. They are used in sailcloth, tyre fabrics, balloon fabrics and other laminated structures, which are used for different types of technical applications.

(Refer Slide Time: 14:26)

Cover factor adjustment factors for weave structure

Weave	Adjustment factor
Plain weave	1.0
2/2 weft rib	0.92
1 / 2 and 2/1 twills	0.87
2/2 matt	0.82
1/3,/3/1 and 2/2 twill	0.77
5 end satin and 5 end sateen	0.69

The comparison of cover factors and their adjustments is provided in the table. In the cover factor adjustments, a plain weave is considered to be 1. The cover factor of 2/2 weft rib is 0.92 times the value of plain weave. For 1/2 twill or 2/1 twill, it is 0.87. For 2/2 matt, it is 0.82, twill weave of 1/3, and 3/1 is 0.77. For satin weave, it is 0.69.

The adjusted cover factor of rib, twill and matt weaves are stated. Multiplying them by these factors to get the typical cover factor of these fabrics, provided all other parameters are the same. This gives the tightness of the fabric. Plain weave is very tight, whereas rib, matt or twill has reduced tightness.

(Refer Slide Time: 16:15)

Typical Characteristics of Fabric

Characteristics	Dimension	
Width (Normal Fabric)	36-160 inch	91- 406 cm
	36-60 inch	91-152 cm mostly
Width (Narrow Fabric)	12 inch	30.5 cm
Fabric weight (areal density) Light weight fabric: Heavy fabric:	 68 - 102 g/m2 173 - 242 g/m2	
Cover factor	12-16	
Crimp	2% - 6 % (warp crimp) 6% - 8% (weft crimp)	
Cover factor (Total) Warp cover factor Weft cover factor	23 -26 20- 22 12- 16	

Typical fabric characteristics are represented in the table. Typical values are stated, and they may also vary. The width of the normal fabric is 91 to 406 cm, roughly 1 to 4 metres. But normal fabrics having a width of 0.9 to 1.5 metres are available. The width of the narrow fabrics is around 30.5 cm. So commercially, these three widths of the fabrics are available. For lightweight fabrics, the areal density is around 68 to 102 g/m^2; for heavy fabrics, it is around 173 to 242 g/m^2.

The total cover factor may typically be between 23 and 26, the warp cover factor 20 to 22, and the weft cover factor around 12 to 16. Crimp value also varies from one fabric to another. The warp crimp could be between 2 to 6%, and the weft crimp could be 6 to 8%. These are typical values represented, which may vary depending on the type of fabric and the type of yarns used in the fabric.

(Refer Slide Time: 18:49)

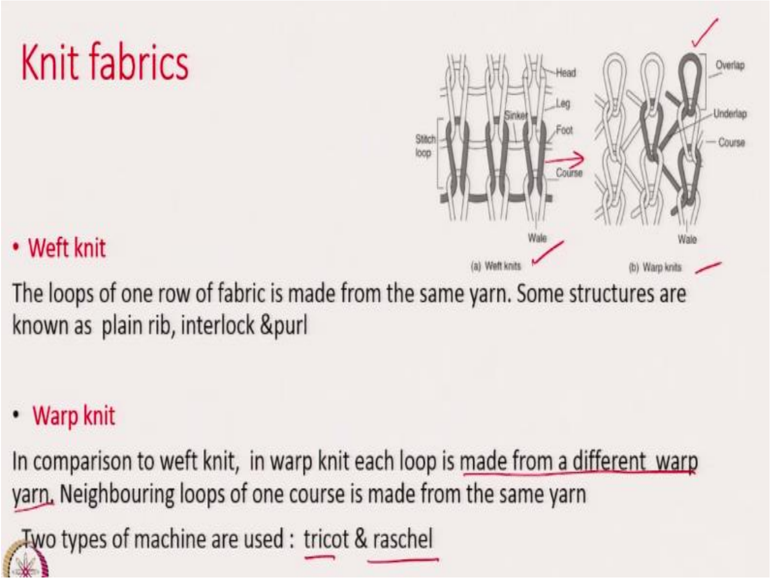
Comparison of properties					
	Plain	Twill	Satin	Basket	Leno
Stability	G	A	P	P	E
Drape	P	G	E	A	VP
Low Porosity	A	G	E	P	VP
Smoothness	P	A	E	P	VP
Balance	G	G	P	G	P
Symmetrical	E	A	VP	A	VP
Low Crimp	P	A	E	P	P/E

A= average, G = good, E = excellent, VP = very poor

The qualitative comparison of specific fabric parameters with different types of fabric construction is represented in the table. In addition to the plain, twill, and satin, another type of weave, the leno weave, is also described. The quality comparison regarding stability, drape, porosity, smoothness, balance, symmetry, and crimp is stated. Here, 'A' stands for average, 'G' stands for good, 'E' stands for excellent and 'VP' stands for very poor. In terms of stability, plain woven and leno fabrics are stable as they do not distort much. Meanwhile, the twill weave is average in terms of structural stability.

For satin and basket weave, the stability of yarns in the fabric structure is less, i.e., they move easily, so the structure gets distorted. This kind of comparative statement about the fibre properties helps the designer choose the type of weave suitable for intended applications. So, the decision of weave type is based on the nature of the application. Hence, various properties of the fabrics in terms of stability, drape, porosity, balance, etc., must be considered while designing.

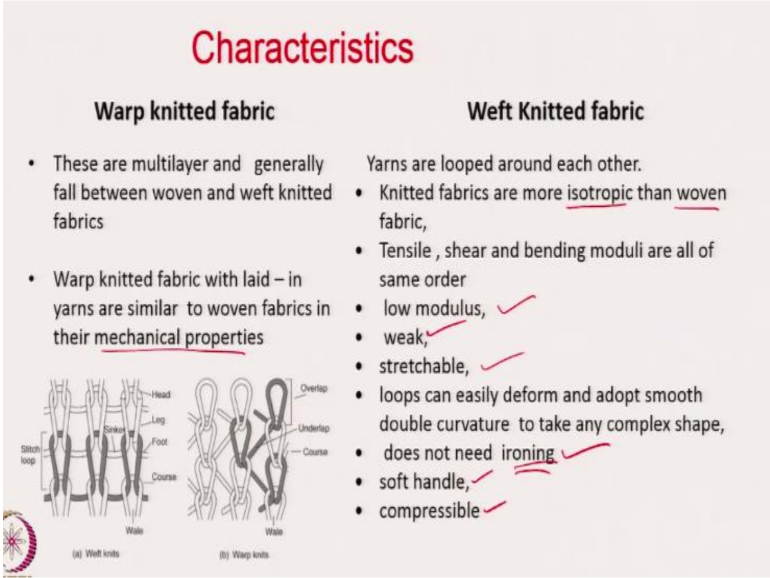
(Refer Slide Time: 21:56)



The next classification of fabric is knitted fabric. They are generally classified as warp-knitted fabrics and weft-knitted fabrics. They are represented in the diagram mentioned. One row of fabric loops is made from the same yarn called weft-knitted fabrics. Some of the weft-knitted structures are plain, rib, interlock and purl.

One row is made from the same yarn the dark line shows in a weft-knitted structure. So, every row represents yarn from one specific cone and neighbouring yarns from other cones. Similarly, in a warp-knitted structure, one wale is made from one particular yarn. In a knitted structure, each loop is made from different yarns. Here, yarn moves in a horizontal direction, and it comes from one particular cone. There are two types of warp-knitted fabrics: tricot and raschel, depending on the type of machine used to produce them.

(Refer Slide Time: 24:07)



Typical characteristics of warp and weft knitted fabrics are listed in the slide. Warp knitted fabrics are multilayer fabrics that generally fall in between woven and weft-knitted fabrics. Warp knitted fabric with laid-in yarns is similar to woven fabrics in terms of mechanical properties. In weft-knitted fabrics, yarns are looped around each other. Tensile, shear and bending moduli are all of the same order for weft knitted fabrics. They have low initial modulus. These fabrics are generally weak in nature and are stretchable because loops can easily deform. The advantage is that it does not need ironing. It is soft, so most of the inner garments are made from knitted fabrics because loops can deform easily. They are compressible in nature.

(Refer Slide Time: 25:35)

Comparison of weft knitted structure

Property	Plain	1x1 Rib	1x1 Purl	Interlock
Appearance	Different on face & back V- shape on face & arc on back	Same on both sides , like face plain	Same on both sides like back on plain	Same on both sides like face on plain
Extension Lengthwise	Moderate : 10-20%	Moderate	Very high	Moderate
Width wise	High : 30 – 50 %	Very high: 50 – 100%	High	Moderate
Area	Moderate to high	High	Very high	Moderate

There are various kinds of structures available within weft-knitted structures. The four structures, plain, rib, purl and interlock, are compared and represented on the slide. A comparative understanding of the structures is needed to know which type of structure is best suited for a specific application. First, comparative statements are given from an appearance point of view. The plain structure has a different appearance on the face and backside, i.e., v-shaped on the face side and arc on the back side. The rib structure has the same appearance on both sides. The purl and interlock structures also have the same appearance on both sides. So, interlock, rib and purl fabrics look exactly similar both on the face and backside, whereas plain or single jersey fabrics have different appearances on the face and backside.

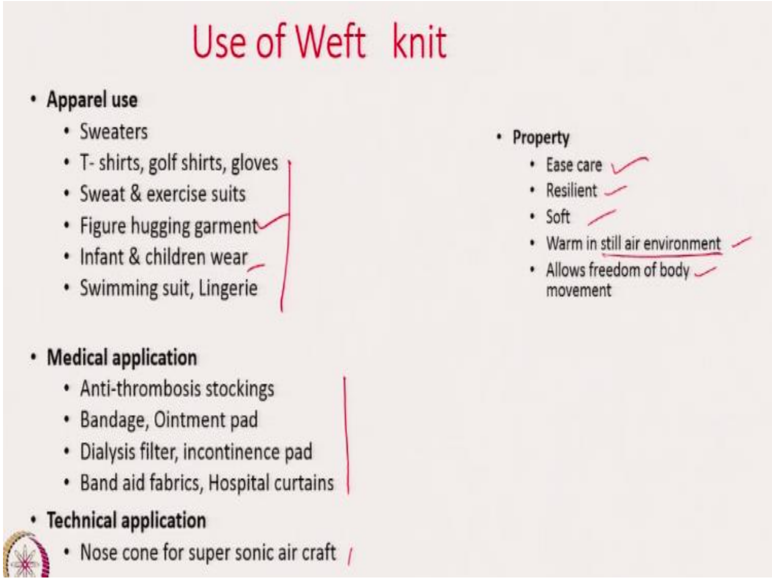
When comparing the extension properties of the fabric, the purl structure gives high extension, whereas other structures give moderate extension. Purl structure exhibits higher extension in both lengthwise and widthwise directions. Plain structure gives about 30-50% higher extension in width-wise directions. Rib structure gives a much higher extension of about 50-100% in width-wise direction, and interlock fabric gives moderate extension. Hence, depending on the type of extension required, the particular type of structure is chosen accordingly. Area-wise extensions are also stated. Purl structure is the best choice when high extensions are required for a particular product. For example, for designing the uniform for highly active sportswear, stretchability is required because of the movements performed. Hence, stretchable fabrics are much more suitable in that case.

(Refer Slide Time: 28:54)

Property	Plain	1x1 Rib	1x1 Purl	Interlock
Thickness & warmth	Thicker and warmer than plain woven made from same yarn	Much thicker and warmer than plain woven	Thicker and warmer than plain woven	Thicker and warmer than plain woven
Un roving	Either end	Only from end knitted last	Either end	Only from end knitted last
Curling	Tendency to curl	No tendency to curl	No tendency to curl	No tendency to curl
End uses	Ladies stockings, fine cardigan, men's and ladies shirt, dresses, base fabric for coating	Top of socks, cuffs, waist band, collars, men's outwear, knitwear, underwear	Children's clothing, thick and heavy outwear	Underwear, shirts, suits, trouser suits, sports wear , dresses

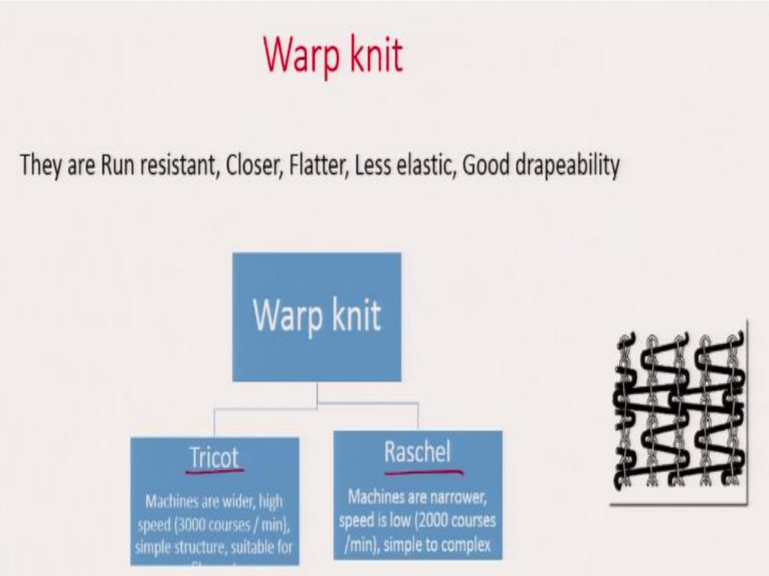
Other comparisons can be made regarding thickness and warmth, un-roving or unravelling capability, curling tendency, and some end uses. In terms of thickness, the thicker the fabric, the warmer it will be. Thicker fabrics are always warmer. Interlock, purl and plain fabrics are thicker, but rib fabrics are much thicker than other fabrics. These comparisons of properties help in choosing the right type of fabrics.

(Refer Slide Time: 29:40)



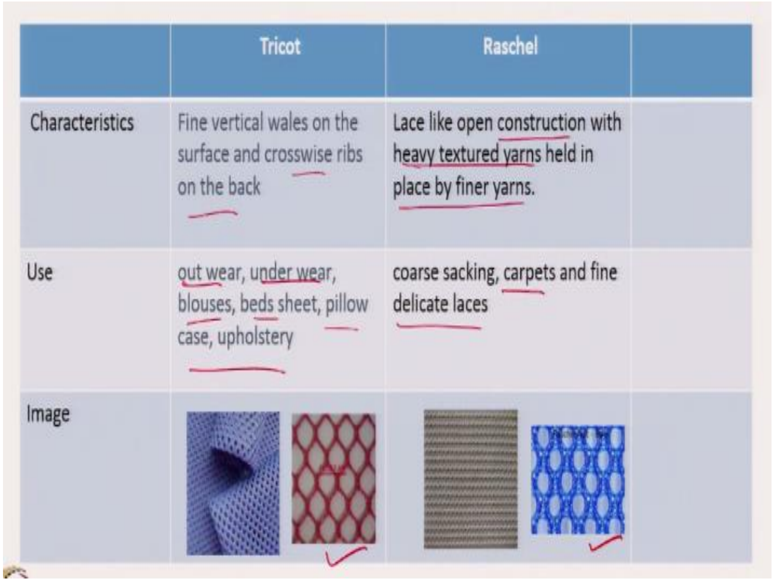
The uses of weft-knitted structures are listed here. The apparel made from weft knitted structures used as sweaters, T-shirts, golf shirts, gloves, figure-hugging garments, etc., are typical applications. Technical applications of these fabrics are also available such as nose cones for supersonic aircraft. Properties are easy to care for, resilient, soft, warm in still air, allow freedom of body movements, etc., Knitted structures are porous; hence, wind can easily penetrate during wind blowing. Hence, in still air, it is warm, but in moving air, air can penetrate the structure and go towards the skin.

(Refer Slide Time: 30:40)



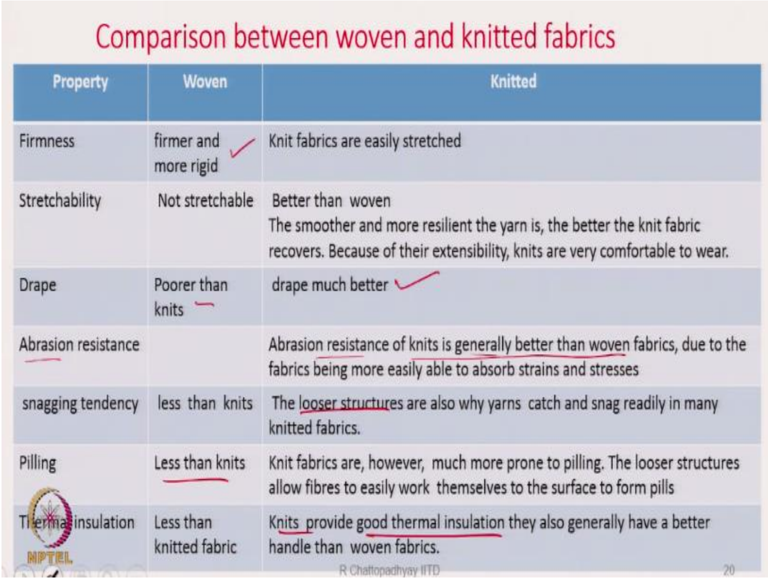
Warp-knitted structures are run-resistant, closer, flatter, less elastic and have good drapability. Warp-knitted structures are classified into two types: tricot and raschel. Two types of fabrics are based on the machines used for producing them. For tricot, the machines are wider and have higher speed, whereas, in raschel, the machines are narrower and have low speed.

(Refer Slide Time: 31:00)



Characteristics of tricot structure are fine vertical wales on the surface and crosswise ribs on the backside. Raschel has a lace-like open construction with heavy textured yarns held in place by finer yarns. Tricot structures are out to wear, underwear, blouses, bed sheets, pillows, etc.; raschel structures are used in coarse soaking, carpets and fine delicate laces.

(Refer Slide Time: 31:50)


Comparison between woven and knitted fabrics

Property	Woven	Knitted
Firmness	firmer and more rigid	Knit fabrics are easily stretched
Stretchability	Not stretchable	Better than woven The smoother and more resilient the yarn is, the better the knit fabric recovers. Because of their extensibility, knits are very comfortable to wear.
Drape	Poorer than knits	drape much better
Abrasion resistance		Abrasion resistance of knits is generally better than woven fabrics, due to the fabrics being more easily able to absorb strains and stresses
snagging tendency	less than knits	The looser structures are also why yarns catch and snag readily in many knitted fabrics.
Pilling	Less than knits	Knit fabrics are, however, much more prone to pilling. The looser structures allow fibres to easily work themselves to the surface to form pills
Thermal insulation	Less than knitted fabric	Knits provide good thermal insulation they also generally have a better handle than woven fabrics.

R Chattopadhyay IITD 20

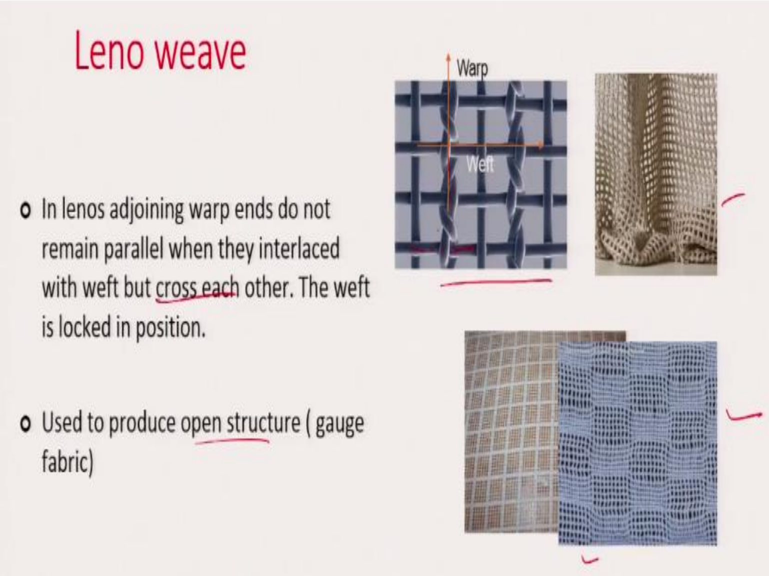
Comparisons of the properties of woven and knitted fabrics are stated in the table. Firmness-wise, woven fabrics are firmer than knitted. Woven fabrics are not stretchable unless elastic yarns are inserted; otherwise, they are not stretchable. They are less stretchable than the knitted fabrics. The drape of the woven fabric is poorer than that of knitted fabrics. Knitted fabrics have better drapeability.

The abrasion resistance of knitted fabrics is generally better than that of woven fabrics. This is because the knitted fabrics are mobile, and when the abrader abrades these, the yarns in the structure can move easily, thereby reducing the stress generated by the abrader. The abrasion resistance of the knitted fabric is expected to be better, provided the yarns are exactly similar in nature.

The snagging tendency of woven fabrics is always lesser than that of knitted fabrics. This is because the knitted structure is loose, and hence, it has poor snagging resistance. Pill formation in woven fabrics is less common than in knitted fabrics. In knitted fabrics, low twisted yarns are used, and hence, fibres from the surface of the fabric come out and get entangled to form pills on the surface.

Pilling in woven fabrics is less because yarn gets support at numerous interlacement points. Knitted fabrics give better thermal insulation because the knitted loops are three-dimensional in nature, and the fabric thickness is higher. Woven fabrics have lower thermal insulation than knitted fabrics.

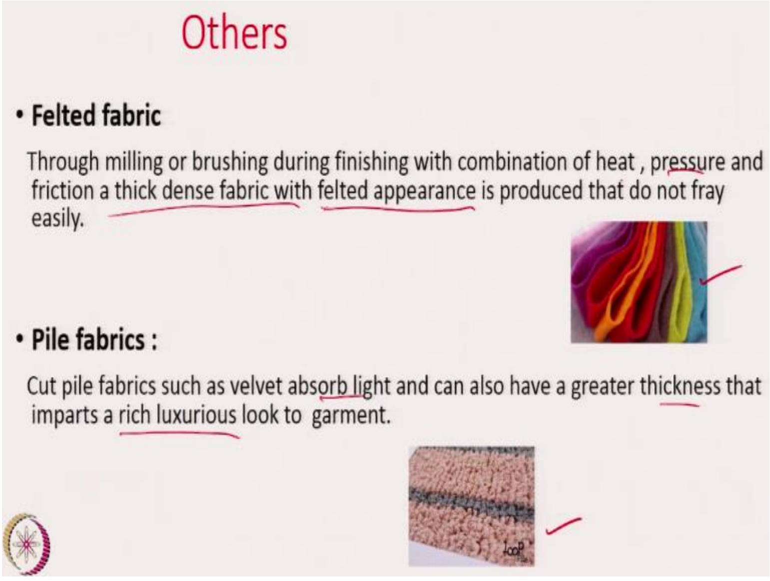
(Refer Slide Time: 34:53)



The leno weave and the way the yarns are interlaced with each other are represented in the figure. The weft yarn is held in position by the pair of leno yarns, so it is not moved easily. In leno, adjoining warp ends are not parallel when interlaced with weft but cross each other. The two yarns cross each other; hence, weft yarns remain trapped and cannot move. So, the relative movement of the weft yarn is almost locked in position. They are gripped by warp yarns crossing each other.

These are used to produce open structures, i.e., gauge fabric. To produce a very open structure, if the structure is made from normal plain weave fabric, warp and weft yarns move relative to each other, and the structure is unstable. Stability is needed simultaneously to produce an open structure, so leno is the best choice. A stable and open structure is required in technical applications, which has a great advantage.

(Refer Slide Time: 37:26)



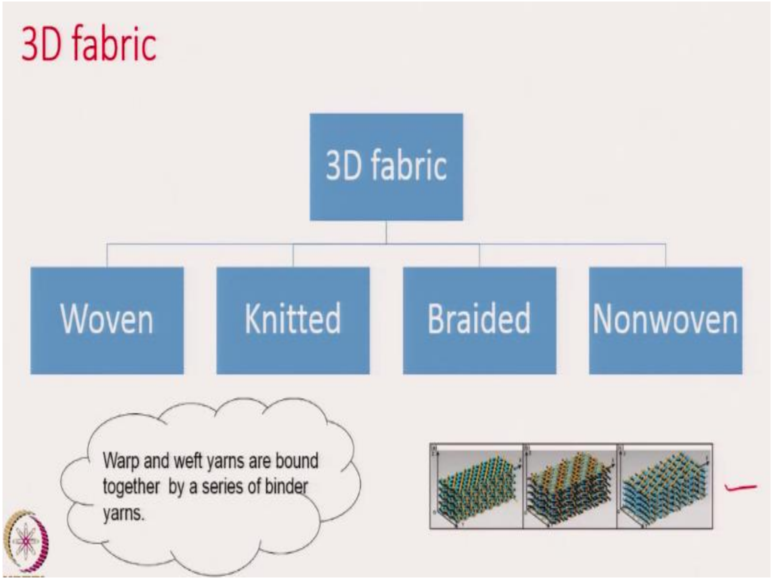
Other fabric types are generally felted fabrics. Through milling and brushing during finishing with a combination of heat, pressure and friction, thick, dense fabrics give a felted appearance. So, dense fabric with a felted appearance is produced that does not fray easily. Generally, they are produced from wool fibres. They can be felt because the wool fibres have scales. So, woollen fabrics are felted by this process and making it from plain woven fabric is impossible. Next is the pile of fabrics. Cut pile fabrics such as velvet absorb light and have a greater thickness, imparting a rich, luxurious look to the garment. Examples are pile fabrics used in towels and carpets.

(Refer Slide Time: 38:57)

Next is the stretch fabrics. Nowadays, lycra stretch fabrics have become more popular. Stretch can be imparted during finishing. It may be inherent in fabric type or added through stretch yarn that uses fibres such as spandex and lycra. Stretch can be introduced during the fabric production process, and hence, the fabric can be made stretchable.

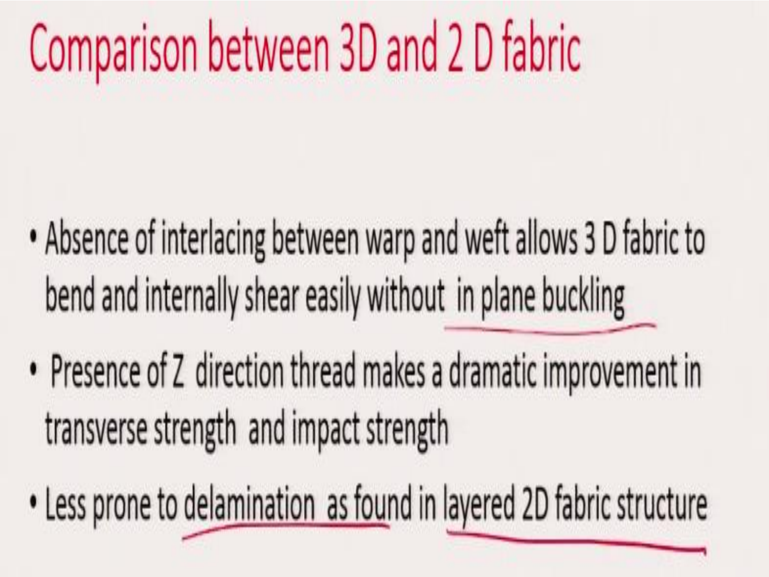
Sometimes, transparent fabrics are required. It is a fabric with very low areal density, and very thin fibres are used. Organza and organdie are examples of semi-transparent crisp fabrics. Softer fabrics in this category are chiffons, georgette, and crepe. These fabrics are transparent in nature and are made from very fine synthetic fibres.

(Refer Slide Time: 40:14)



Woven, knitted, braided and nonwoven are all 3D fabrics produced by weaving, knitting, braiding and nonwoven technology. In 3D woven fabrics, the warp and weft yarns are bound together by a series of binder yarns. An example of 3D knitted fabrics is spacer fabrics.

(Refer Slide Time: 40:56)



A comparison is made between 3D fabrics and 2D fabrics, as provided on the slide. The absence of interlacing between warp and weft allows 3D fabrics to bend and internally shear easily without in-plane buckling. The presence of 'Z' direction threads drastically improves transverse and impact strength. 2D fabrics could be very strong in the 'XY' plane; the layers of 2D fabrics make them thicker, but strength is not good in the 'Z' direction.

Therefore, 3D fabrics are produced in which the structure has yarns running in the 'Z' direction. Yarn in the 'Z' direction, other than the 'XY' direction, makes the fabric have better strength in the transverse direction of the fabric. As a result, they are less prone to delamination as found in layered 2D structures. If a sandwich structure of 2D fabrics is made by pressing them and making thicker structures, i.e., 2D fabrics are placed one over the other.

The problem is that whatever techniques are used to join such a structure, there is a chance of delamination. This is one of the major weaknesses of the 2D structures. When some forces act on the structure, the impact energy acts on it and causes delamination problems; hence, 3D structures are preferred over sandwiching several 2D fabrics.

(Refer Slide Time: 43:36)

3 D woven structure	3 D Knitted structure	3 D braided structure	3 D stitched fabric
Complex near net shaped preforms. Properties can be tailored for specific application	Better formability	Complex shapes can be produced	
Composite with complex geometry is less expensive to produce	can produce near net shape preform	It is in expensive and simple to manufacture	simple to manufacture
	Sandwich composite have lower specific density		Improved delamination resistance to impact
Better delamination resistance	Some structure have higher impact damage tolerance and energy absorption	Better delamination resistance and impact damage	improved joint strength under monotonic and cyclic loading
Higher inter laminar fracture toughness		Less sensitive to notches	Better impact damage resistance

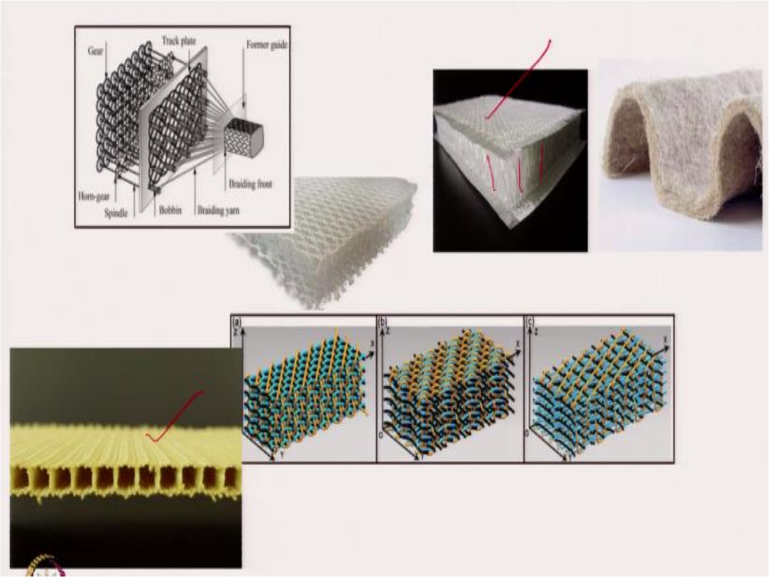
NPTEL R Chattopadhyay IITD 26

The table lists a comparison of different types of 3D fabric structures, such as 3D woven, 3D knitted, 3D braided and 3D stitched fabrics. Properties of these fabrics can be tailored for specific applications. 3D knitted fabric structure has better formability. In 3D braided structures, complex shapes can be produced with the 3D braiding machine.

In 3D woven fabrics, composites with complex geometry are less expensive to produce. 3D structures can produce many composites, and 3D woven structures have better delamination properties. This means that the layers will not separate easily from each other. They have higher interlaminar fracture toughness. 3D knitted structures can produce near-net shape preform. Sandwich composites have lower density.

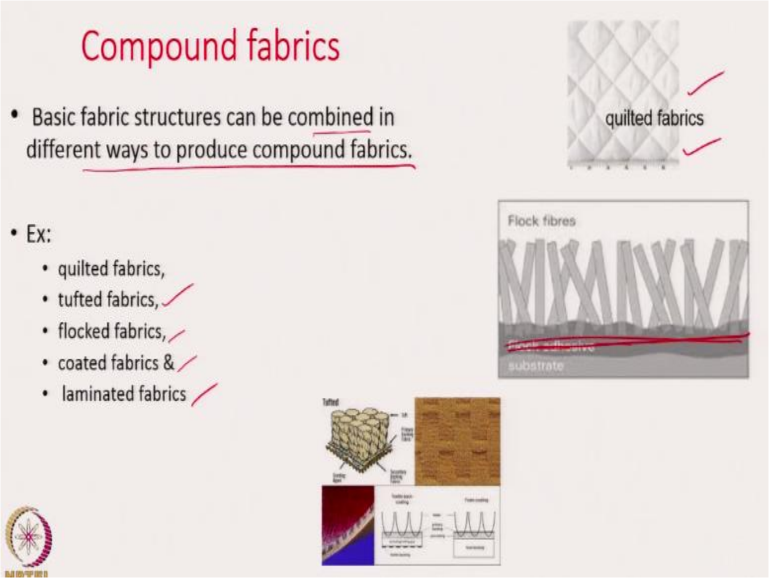
Some structures of higher impact damage tolerance and energy absorptions. 3D knitted structures are available nowadays and can be made on warp knitting machines. 3D braided structures also have better delamination resistance and impact damage but are less sensitive to notches. Hence, there are different types of production techniques that can be used for producing different types of structures, and the properties of such structures depend on the production technique used.

(Refer Slide Time: 45:31)



Some of the 3D fabric images are shown. Spacer fabric is also shown, and the vertical yarns are generally called spacer yarns. These are the specific applications of such kinds of fabrics. 3D fabric structures with holes are also seen, and hence, very complex structures can be created for different types of end-use.

(Refer Slide Time: 46:10)



The other type of fabric is the compound fabric. Compound fabrics are the combination of two types of fabrics made from two different technologies. Basic fabric structures can be combined in different ways to compound fabrics. Examples are quilted, tufted, flocked, coated, and laminated fabrics. These are the various types of compound fabrics. There are two sheets of quilted fabrics, and a lot of loose fibres are in between the sheets. They are stitched to form a quilt fabric.

Quilted fabrics are used as comforters and for other applications such as extreme cold weather garments. A lot of insulation can be created in the quilted fabrics. There are different types of techniques available for producing quilted fabrics. In these fabrics, fibres are flocking on a typical fabric surface, which could be woven fabrics, and then there are vertically laid fibres and fabric, which are called flat fabrics. Velvet fabrics are the typical examples of flock fabrics.

(Refer Slide Time: 47:54)

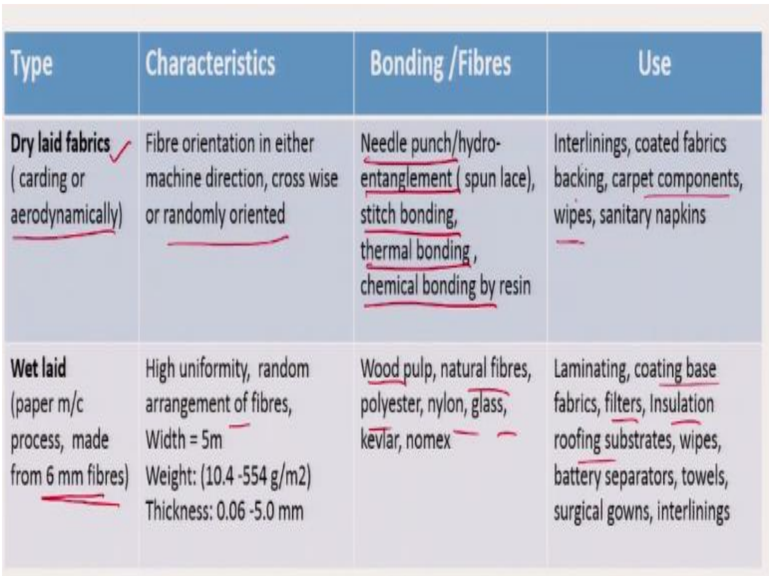
Compound Fabric type	Description
Quilted fabrics	Fabrics consisting of a filler material sandwiched between two fabrics
Tufted fabrics	Fabrics which have a yarn pile (of loops or tufts) inserted into a backing fabric. The pile stands vertical at 90 degree to the backing fabric
Flocked fabrics	Fabrics which have flock attached to a base fabric – usually by an adhesive. The resultant fabrics have a velvet-like feel
Coated fabrics	Fabrics which have had a layer or layers of a coating applied
Laminated fabrics	Fabrics which comprise layers joined together by an adhesive or by the adhesive properties of one of the layers

The descriptions of the compound-type fabrics are listed in the table. Quilted fabrics consist of a filler material sandwiched between two fabrics. Tufted fabrics have a pile of yarn inserted into the backing fabric. Flocked fabrics have flocks attached to a base fabric, usually by an adhesive. The resultant fabric has a velvet-like feel. Coated fabrics have a layer of coating applied. Laminated fabrics comprise layers joined together by an adhesive or by the adhesive properties of one of the layers.

(Refer Slide Time: 48:31)

Next is the nonwoven fabrics. This is another technology used to produce a two-dimensional or three-dimensional sheet, depending on the required thickness or areal density. The different production techniques for nonwoven fabrics are dry laid, wet laid, spun bonded, melt blown, and electrospun. In fabric manufacturing courses, more detailed information is typically provided. However, having a basic understanding of fabric characteristics and their current uses can be very helpful. With this knowledge, when we need to select a fabric, we can consider the available options and, through careful thought and analysis, make a decision about which fabric to choose.

(Refer Slide Time: 50:01)



Type	Characteristics	Bonding /Fibres	Use
Dry laid fabrics (carding or aerodynamically)	Fibre orientation in either machine direction, cross wise or randomly oriented	Needle punch/hydro-entanglement (spun lace), stitch bonding, thermal bonding , chemical bonding by resin	Interlinings, coated fabrics backing, carpet components, wipes, sanitary napkins
Wet laid (paper m/c process, made from 6 mm fibres)	High uniformity, random arrangement of fibres, Width = 5m Weight: (10.4 -554 g/m2) Thickness: 0.06 -5.0 mm	Wood pulp, natural fibres, polyester, nylon, glass, kevlar, nomex	Laminating, coating base fabrics, filters, Insulation roofing substrates, wipes, battery separators, towels, surgical gowns, interlinings

Dry-laid fabrics can be produced either through carding or aerodynamic methods. The fibres can be oriented in the machine direction, crosswise, or randomly, which defines the fabric's characteristics. Bonding can be achieved through needle punching, where needles are punched into the fabric. Other bonding methods include hydroentanglement, stitch, thermal, and chemical bonding using resin, as the fibres are initially loose.

The fibres need to be held together to give the fabric strength, and there are various methods to bond the fibres within the fabric. Some common applications of these bonded fabrics include interlinings, backing for coated fabrics, carpet components, and wipes. Another method is the wet-laid process, which typically uses very short fibres, around 6 mm long. This process is commonly used to make products like papermaker's felt.

Wet-laid fabrics offer high uniformity and random fibre arrangement and can be made from various fibres, including wood pulp, natural fibres, polyester, nylon, and glass. These fabrics are used in applications such as laminating, coating base fabrics, filters, insulation, and roofing. There are numerous uses for wet-laid fabrics. For more detailed information on these fabrics, including production techniques, properties, and applications, relevant textbooks provide in-depth coverage.

(Refer Slide Time: 52:10)

Type	Characteristics	Bonding /Fibres	U se
Spun laid or spun bonded (thermoplastic polymer)	Orientation of fibres can be varied, high strength and tear resistance	Polyester, nylon,, polyethylene, PP	Interlinings, carpet backing layers, bagging, packaging, filtration, wall coverings
Melt blown	web consists of very fine filaments having dia 1-4 micron, softer & weaker than spun bonded	PP , Polybutyal terepthalate	In composite or laminated form, suitable for high efficiency filters,
Electro-spun	Fibre dia : 0.25 micron, very fine thickness 1 micron, deposition on a substrate		

Next are techniques like spun-laid, melt-blown, and electro-spun. These processes all produce nonwoven fabrics, but the characteristics and properties of the fabrics differ depending on the technique used. Fibre orientation can vary in spun-laid or spun-bonded fabrics, resulting in higher strength and tear resistance. Common fibres used in these processes include polyester, nylon, and polyethene. Each method contributes to unique fabric properties suited to specific applications.

Only thermoplastic fibres are needed for these processes, and there is no need for additional resin to bind the fibres. The web consists of very fine filaments in melt-blown nonwovens with diameters ranging from 1 to 4 microns. This method is ideal for producing nonwovens with very low areal density (grams per square meter). Melt-blown nonwovens made from fine fibres are the perfect solution for extremely thin fabrics, such as 50, 40, or 30 g/m^2.

In most face masks, the inner fabric layer is made using the melt-blown technique, which produces fine fibres and very thin fabrics. This combination is ideal when low areal density fabrics and micron-level pore sizes are required, making melt-blown fabrics perfect for filtration. The electro-spun technique can also be used to produce nonwoven fabrics, offering another method to create fine fibre structures with unique properties for specific applications.

We discussed the various fabrics available to us, along with their general characteristics. By understanding these different fabric types and their properties, we are better equipped to make informed decisions when choosing fabrics for specific applications. With that, we conclude this session. Thank you!