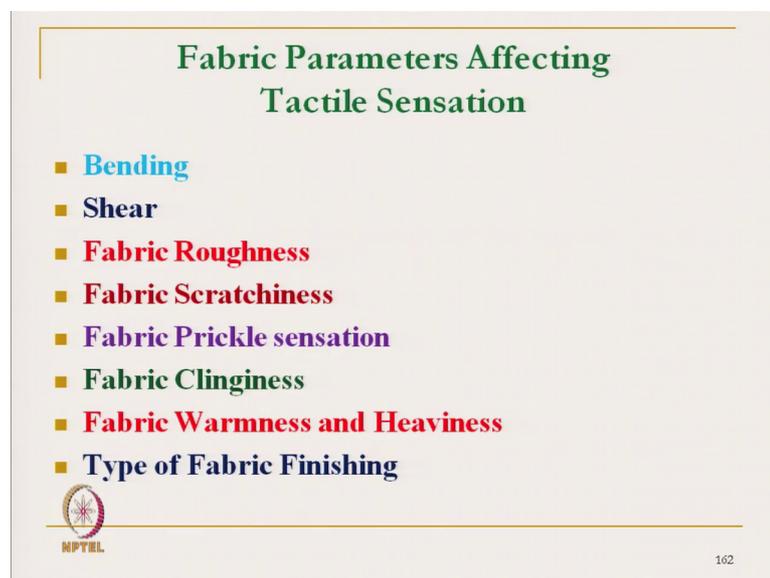


Science of Clothing Comfort
Prof. Apurba Das
Department of Textile Technology
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Lecture – 21
Tactile Aspects of Clothing Comfort (contd...)

Hello everyone. Now we will continue with the different parameters of fabric which affect the tactile sensation.

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**Fabric Parameters Affecting
Tactile Sensation**

- **Bending**
- **Shear**
- **Fabric Roughness**
- **Fabric Scratchiness**
- **Fabric Prickle sensation**
- **Fabric Clinginess**
- **Fabric Warmness and Heaviness**
- **Type of Fabric Finishing**


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So, these are the parameters bending, shear, fabric roughness, fabric scratchiness. And these are the tactile sensation, fabric prickle sensation, clinginess warm and heaviness of the fabric and type of fabric. So, this are the different sensations and related fabric parameters.

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Fabric Parameters Affecting Tactile Sensation,

Effects of **weave density, **yarn twist** and **yarn count** on fabric handle of polyester woven fabrics by objective evaluation method**

Taffeta is the most basic fabric consisting of **twistless continuous-filament** yarn in both warp and weft directions. Weft yarn density was changed (**Stiffness**)

Taffeta is a crisp, smooth, plain woven fabric made from silk or synthetic fibres.



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So, that we have mentioned in last class that this study talks about the density of yarn. So, weave density, yarn twist and yarn count. So, and here, it is only polyester filament has been used, continuous filament and woven fabric.

So, these are the all the fabrics related to the polyester continuous filament woven fabric. Taffeta is the fabric where it is a twist less continuous filament is used for both warp and weft yarn and where the weave density is changed. Here weave density is changed to change the fabric stiffness, and it is a classified by crispness, smoothness, it is a smooth, crisp plain oven fabric it is a made of either a silk or synthetic fiber. Here we have used actually it has been it has been taken that it is a polyester continuous filament.

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Fabric Parameters Affecting Tactile Sensation,

Effects of **weave density, **yarn twist** and **yarn count** on fabric handle of polyester woven fabrics by objective evaluation method**

Crepe De Chine consists of **weft continuous-filament yarn with high-twist and twistless or low-twist warp continuous filament yarns, having small crepes on the surface**. Weft yarn density and weft yarn twist were changed for investigation.



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Then Crepe De Chine it is a continuous filament with a high twisted weft yarn, along with the twist less or low twisted warp yarn. So, the combination which keeps the small crepe structure at the surface. On the surface it gives a small crepe structure, here weave density and yarn twist, weave yarn twist are changed.

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Fabric Parameters Affecting Tactile Sensation,

Effects of **weave density, **yarn twist** and **yarn count** on fabric handle of polyester woven fabrics by objective evaluation method**

Georgette consists of **high-twist continuous-filament yarn in both warp and weft**, having small crepes on the surface. **Georgette 2** has smaller level of twist than **Georgette 1**.



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So, next type of fabric is Georgette; where both warp and weft yarns are high twisted.

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Fabric Parameters Affecting Tactile Sensation,

Effects of **weave density, **yarn twist** and **yarn count** on fabric handle of polyester woven fabrics by objective evaluation method**

Pongee is made of **false-twist continuous-filament** yarn for **both warp and weft**. The name pongee is used mainly for silk fine-dress fabrics. Weft yarn density was changed here. **(Flexible and fullness)**



This one is it is a called pongee, this made of false twists textured yarn it gives a bulk. So, continuous polyester filament which is actually false twisted, and the false twist is used both for warp and weft. So, the name pongee is used mainly for fine silk fabric. But that here it is used for polyester textured fabric to give fullness and flexibility. So, here again weave density was changed. So, pongee fabric it is a it gives the fullness, softness.

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Fabric Parameters Affecting Tactile Sensation,

Effects of **weave density, **yarn twist** and **yarn count** on fabric handle of polyester woven fabrics by objective evaluation method**

Yoryu (Chiffon) consists of **warp continuous-filament** yarns with **high-twist (Z)** and **weft continuous-filament** yarn with **high twist of left-handed twist (S)**. Large crepes are shown on the surface in **warp** direction. **Weft yarn density and weft yarn twist were changed here.**



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Chiffon; so, it consists of high twisted yarn, like Georgette, but the difference is that one yarn is that warp yarn is Z twisted and weft yarn is S twisted. So, the characteristics of

this Chiffon it is very commonly used fabric. It is give it gives large crepe structure at the surface, in warp direction. So, due to the twist direction, it gives crape, but it is direction is different. Here again weft yarn density and weft yarn twist are changed. So, these are the different fabrics you have it has been studied.

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Fabric Parameters Affecting Tactile Sensation,

To obtain primary handle of those samples objectively, **KN-201-LDY** equation (Kawabata, 1980) was used. The equation is as follows:

$$Y = C_0 + \sum C_i \{(X_i - M_i) / \sigma_i\}$$

Where,

Y is primary handle value obtained objectively,

X_i is mechanical parameter measured by KES system. There are 16 parameters selected from tensile, bending, shearing, surface, and structural properties of fabric,

C₀, C_i are coefficients obtained from regression,
C_i is contribution ratio of mechanical parameters to each primary handle value ,
M_i is average value of X_i, and σ_i is standard deviation of X_i.

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And the primary hand value was actually obtained using this equation, as we have already discussed earlier. So, these are the primary hand value it is the contribution ratio C_i it gives.

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Fabric Parameters Affecting Tactile Sensation,

- Koshi increased with weft yarn density primarily for almost all the fabrics

Density, picks/m

Taffeta: twistless continuous-filament ~ Stiffness

Pongee: false-twist continuous-filament ~ Flexible and fullness

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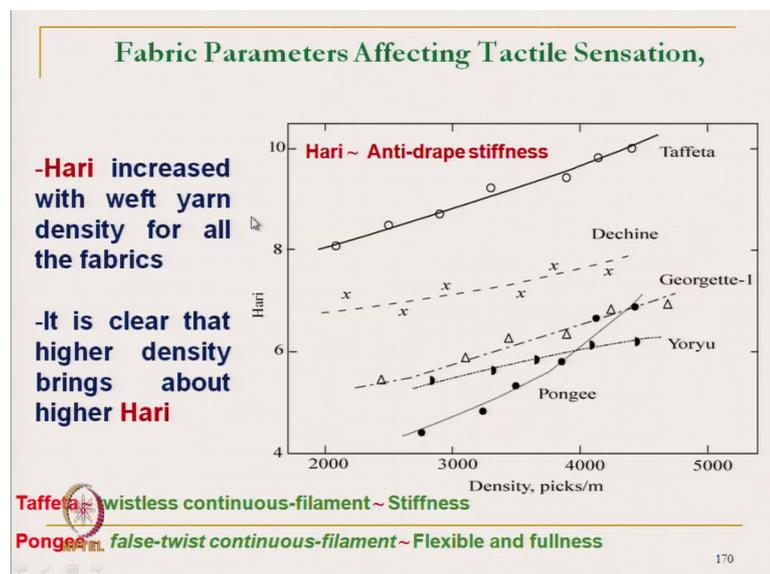
Now, let us see the how different the hand expressions are actually we are getting with changing with different fabric parameters. A Koshi, what is Koshi? We have discussed Koshi is type of stiffness, it is a stiffness.

Now, the let us see take the 2 extreme value see intermediate we are not going to discuss here, let us see the 2 extreme value the Koshi highest Koshi is it is a Taffeta. Taffeta is got highest Koshi and lowest Koshi value it is a pongee. So, Koshi increases with the weft yarn density; that means for all the almost all the fabric, if we change the weft picks per inch or pics per centimeter the Koshi value the type of softness, stiffness Koshi is talking about type of softness feeling Koshi is talking about, it is it increases with the increase in the weave density.

So, for a compact fabric we get a type of stiffness which is Koshi. And now let us see why the Taffeta is giving higher Koshi value. What is Taffeta? It is a twist less continuous filament. And pongee it is a false twisted continuous filament. That means, if we use the false twisted yarn, the type of flexibility will achieve. It is a type of flexibility will achieve, it will it gives the Koshi value lowest Koshi value.

Similarly, if the filaments are straight without any finish, without any twist that means, it will this filament will give us a continuous assertion that a beam which will give some stiffness. So, that the stiffness which we get from a continuous filament fabric, it gives the feel of Koshi filing.

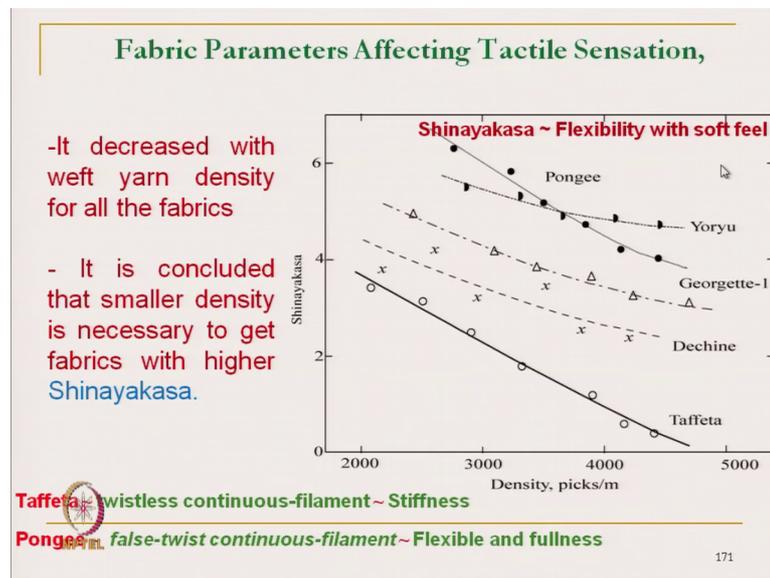
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Next Hari; Hari is the anti-drape stiffness; that means, the fabric will not be able to adopt the surface of any surface, the Hari in general for all the fabric increases with the increase in weft density. So, it is clear the if we change the weave density, the type of stiffness which will achieve it will be anti-drape type of stiffness; where the fabric will not be able to adopt the surface.

So, higher density brings about higher Hari value. Now again let us try to see the 2 extreme value the pongee and the Taffeta. Taffeta again it is a twist less continuous filament, and pongee is false twisted continuous. So, it is like earlier one. So, Hari also is actually related with the wave density type of yarns used. So, if we try to get so, from here our idea is if we try to develop a fabric, which will have better drip, better fabric will take the shape our body, then we should have a lower Hari value. And to get that thing, you should not use a continuous filament. So, if we wear a continuous filament fabric, it will definitely be stiffer in nature it will give certain type of tactile sensation.

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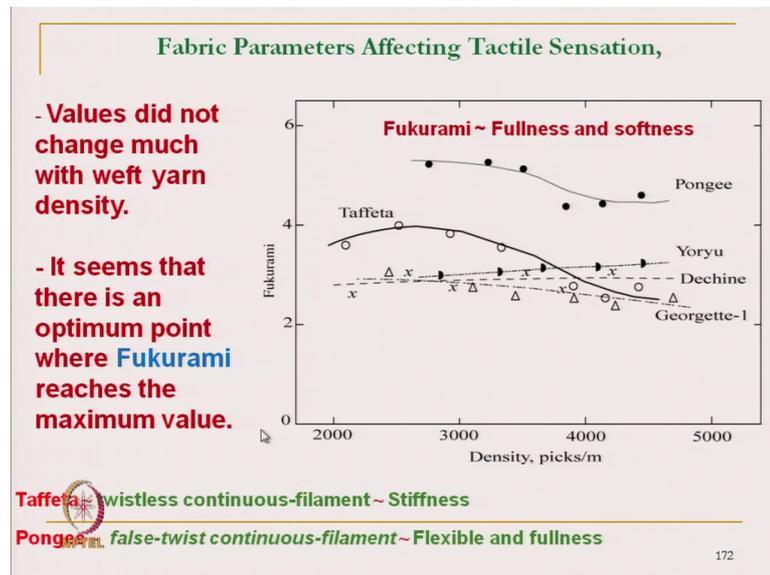


Shinayakasa, it is flexibility with soft feeling. So, as we keep on increasing the density of peak so, that type of flexibility will drop will reduce. And also that shaft filling will not be there. So, keeping the same yarn if we in keep on increasing the weft, that the type of soft filling and flexibility will lose, it is a shinayakasa.

So, it decreases with the weave density. So, it is concluded that smaller density is necessary to get fabric with a higher shinayana. So, if we want the flexibility with little

bit soft feeling so, we have to reduce the weave density first. And also here if you see the Taffeta which is made up twist less continuous filament, it is again it gives lowest shinayakasa, it is flexibility is low. Whereas, pongee it gives higher shinayakasa.

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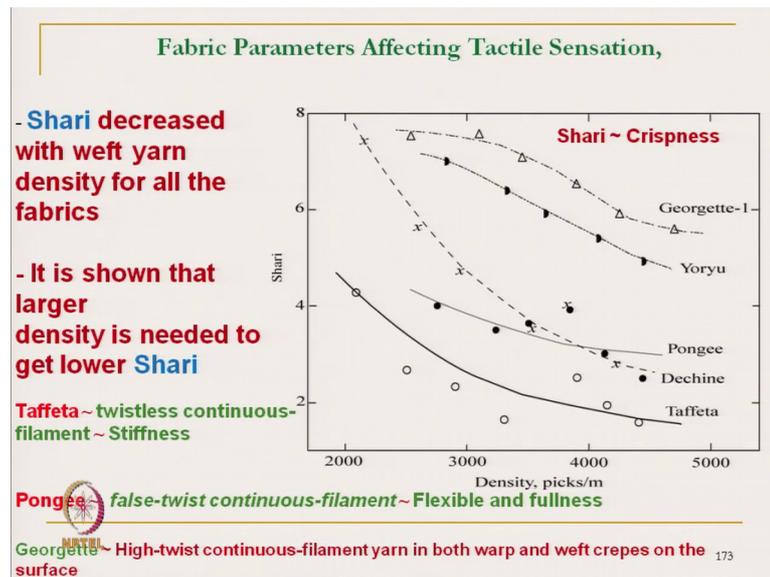


Fukurami, it is a fullness it is a sense of fullness or softness of fabric. And if we see its effect on weave density is not that significant. All the it is changes little bits not there is no stand a norm so, when trend.

So, fullness and softness it is not that the Fukurami, it is not affected by too much by the change in weave density at least within this range. But, if we see the pongee which is made of false twisted yarn which gives fullness fabric and soft feeling. So, if we go for, if we want fabric a soft feeling fabric higher Fukurami we can go for this type of yarn. Twist less sorry, false twisted yarn and Taffeta with a say the Georgette Georgette with high twisted.

So, it gives less Fukurami value, fullness will it is a type. And even Taffeta is more than George Georgette; that means, with lower twist fabric, the 0 twisted fabric gives a little bit better fullness, better softness than the heart twisted a fabric.

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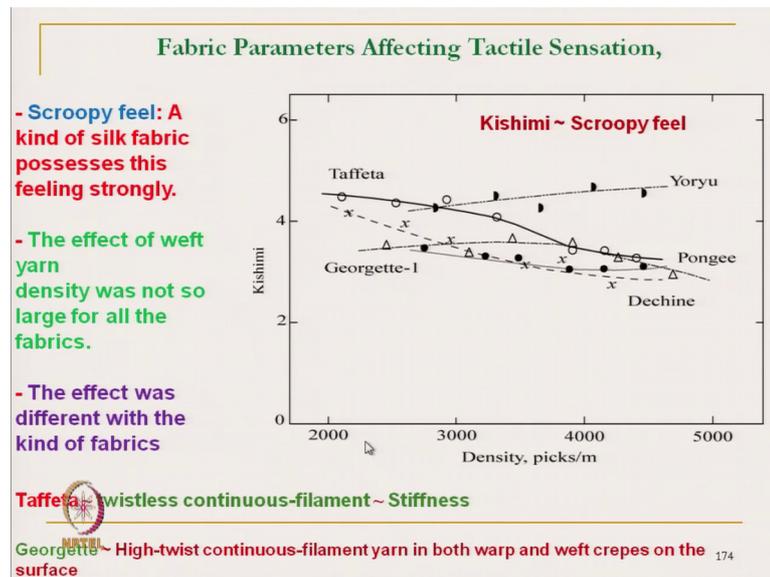


Shari it is a crispness, crispness always is lost when which increase the yarn density because crispness as we have discussed it is related with the stick slip type of a measure. So, it decreases so, if the fabric is the weave density is increased.

So, the crispness of the fabric will be lost. So, if we want higher crispness so, we have to use the less weft density. The larger density is needed to get lower Shari value. So, if we want to reduce the crispness of the fabric, some of the feeling due to crispness the tactile sensation and we can get some scratchiness scratchiness feeling, that we get with the higher Shari value higher crispness. So, if you want to reduce, then we have to reduce the, I increase the density.

Now Georgette gives very high crispness. That is due to the crepe available, that is a small crepe available due to high twisted, that gives higher crispness. But the Taffeta with the twist less yarn gives less crispness, because it is a twist less one. And the pongee also it is a lower, which is made up falls twisted yarn.

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Next is the scroopy feeling Kishimi, it is a kind of to silk like feeling. The silk filling, this silk type of silk fabric possesses this type of nature. The effect of weft density it is not that prominent here. So, weft density is a does not have that much effect. The effect was different with the different kinds of fabrics. So, it is not so, for Taffeta the scroopy feeling reduces with the with the weave density.

So, Taffeta is continuous filament. So, scroopy feeling if we take twist less filament, if we have used the lower density, then will get certain feeling. That feeling is called square that is scroopy feeling. And if we increase the, if we make a compact fabric made of the twist less filament, that that is scroopy fill that Kishimi will be lost. So, it is it is reducing, this is an interesting and Georgette, you said just read Georgette it increases little bit due to that. So, the different types of fabric they give different nature of a scroopy feeling.

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Fabric Parameters Affecting Tactile Sensation,

Koshi ~ Stiffness Shinayakasa ~ Flexibility with soft feel Shari ~ Crispness

Contribution ratio of mechanical parameters; C_i to **Koshi** ; **Shinayakasa** and **Shari** by KN-201LDY equation.

Koshi: +B (37%), -2HG (13%), -2HB (12%), -WT (11%)

Shinayakasa : - B (44%), -MMD (10%), - G (10%), -2HB (7%)

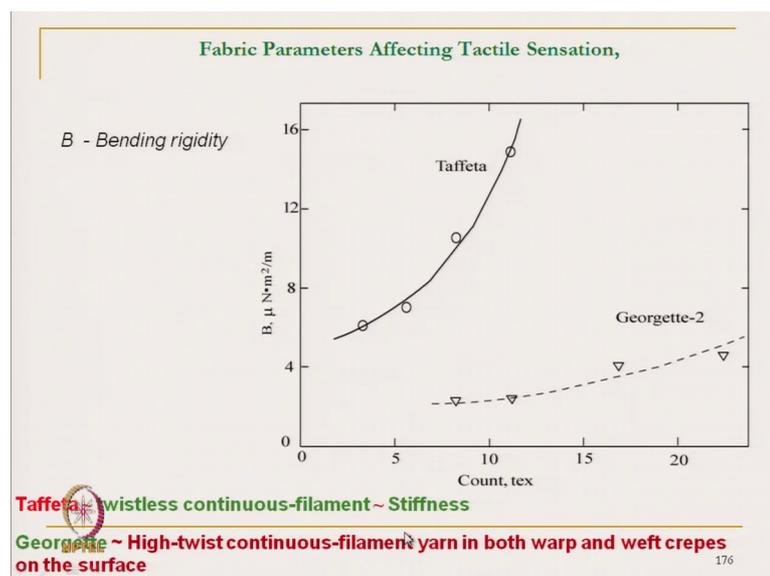
Shari: -G (32%), +MMD (29%), +SMD (8%), +RC (7%)

WT Tensile energy; B Bending rigidity ; 2HB Bending hysteresis; G Shearing stiffness; 2HG Shearing hysteresis ; RC Compressional resilience; MMD Mean deviation of MIU; SMD Geometrical roughness;

Note. Sign of mechanical parameter: +, increasing direction; -, decreasing direction

So, this are the different weight edge that we have discussed earlier also. So, for Koshi it is bending rigidity is measure positive parameter. Whereas, the this shear hysteresis is the negative parameter. Shinayakasa which is actually flexibility with soft fill; where the bending rigidity is a negatively it is affecting. Shari it is bending rigidity is negative affecting and mean deviation of mean MMD is positively affecting. What does it mean? That means higher MMD will give higher crispness.

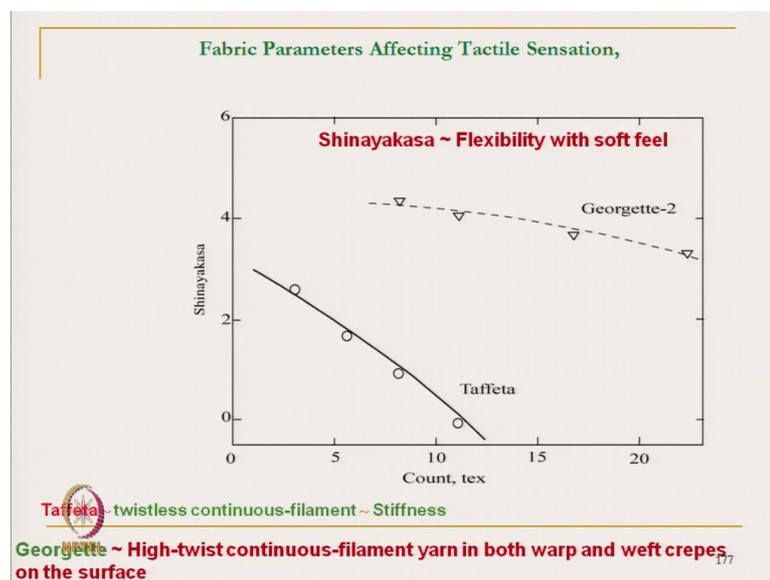
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Now, try to see the bending rigidity. So, here the count of yarn is changed. So, as the tex of yarn increases, the bending rigidity of the fabrics also increases. But it is interesting that twist less continuous filament the great of increases very sharp. Because of it is like it acts as beam. So, as we increase the diameter of the filament it increases.

But in Georgette, where high twisted yarn are used, it is a crepe is present. So, that is why it is also increasing, but the rate of increase is not that it is almost flat. So, for Taffeta if we want to increase the bending rigidity. So, count we can always increase.

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Shinayakasa it is a flexibility with soft feeling. Now, here you can see with the count if we increase the count of yarn; that means, you were increasing the yarn diameter; that means, flexibility will be lost, and it is at higher rate for twist less filament and at lower rate in the twisted filament, highly twisted filament. So, all these parameters you have discussed, the effect of yarn count effect of type of filament on different types of handle related aspects. Now we will discuss the other parameters like fabric roughness.

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Fabric Roughness

- **The sensation of fabric roughness is correlated with,**
 - **Fabric surface roughness characteristics**
 - **frictional force;**
 - **mean surface roughness coefficient; and**
 - **deviation of surface roughness coefficient**
 - **Compressional characteristics**
 - **compressibility and compressional energy**
 - **Fiber diameter**
 - **Tensile characteristics of fibre**
 - **breaking load and breaking elongation**

Tensile characteristics of fabric

- **breaking elongation, elastic recovery**

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Now, fabric roughness is a tactile sensation; which we get when the fabric is in directly contact with the skin. And that now we will try to understand what are the factors and if we know the different factors then you can control the roughness. The sensation of fabric roughness is correlated with the fabric surface roughness. So, if we know the fabric surface roughness then we can predict the roughness of the fabric. And it is related with the fabric frictional force and mean surface roughness coefficient.

So, this value we can get from the objective measurement, and then we can predict the whether the fabric will be rough or smooth and also deviation of surface roughness coefficient. So, that a MMB we can get. And also fabric roughness surface roughness is related with the compressional characteristics. Even if the fabric is rough; suppose a mean deviation of surface roughness it is high, but if the fabric is highly compressible, in that case fabric may not feel a rough.

So, these are all interrelated. If the fabric is frictional forces very high. So, for soft fabric, it may be feeling may be totally different, it may not be that rough, but a fabric with really highly stiff we not compressible fabric. Even a small change in frictional force or small change in surface roughness will give a very rough feeling.

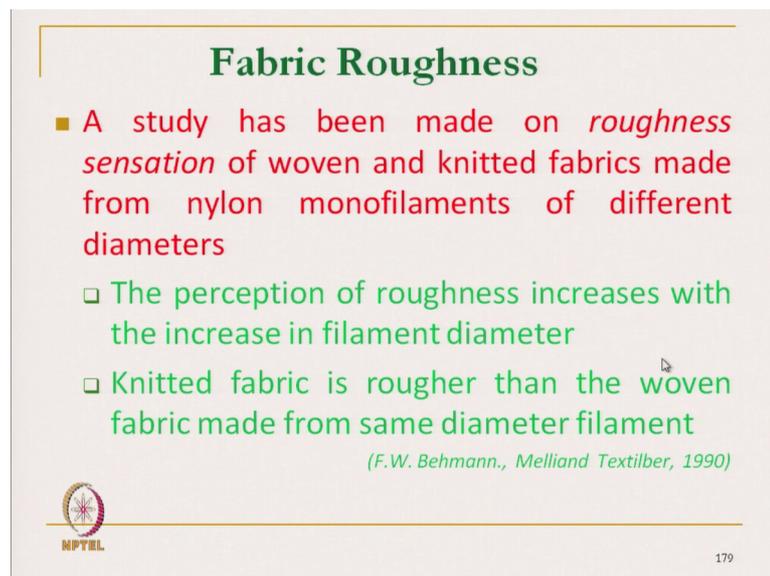
So, it is a compressibility is another parameter; which is related with the fabric surface roughness. So, fabric roughness apparently we mean it is a surface characteristics. It is

not the only the surface characteristics, it is a ball characteristics also it is a compression so, compressibility and compressional energy; if the compressible energy is less, what is compressional energy? It is a energy required to compress.

So, that energy if it is less or compressional in a compressibility is high, then the fabric may not feel rough, then coming to the fiber diameter. So, keeping all these parameters same, if we use the fabric fiber with a fabric with higher fiber diameter, then we will fill roughness. So, it is a fabric tensile characteristics or fiber tensile characteristic. That is directly related with the roughness, of fiber with a higher young's modulus will give roughness.

So, breaking elongation and breaking load. So, and tensile characteristics of fabric also, a fabric it is a very stiff fabric will give a rough sensation, breaking elongation and breaking elastic recovery of fabric.

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Fabric Roughness

- A study has been made on *roughness sensation* of woven and knitted fabrics made from nylon monofilaments of different diameters
 - The perception of roughness increases with the increase in filament diameter
 - Knitted fabric is rougher than the woven fabric made from same diameter filament

(F.W. Behmann., Melliand Textilber, 1990)

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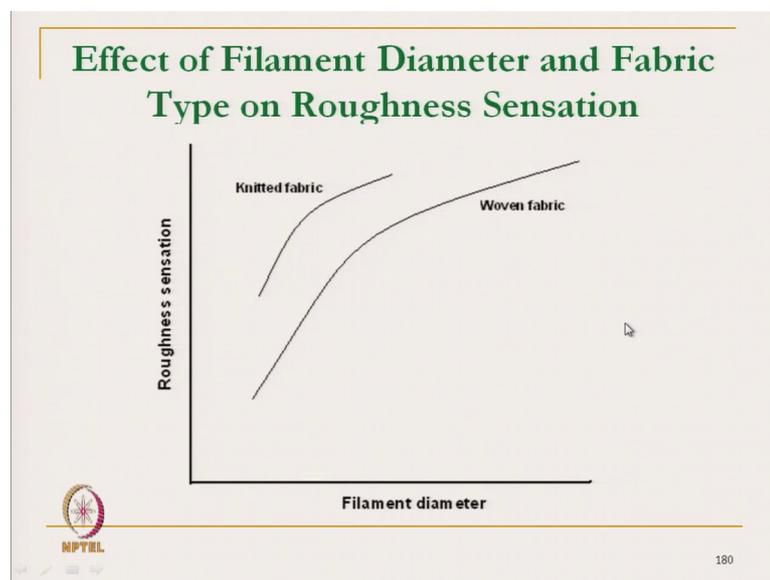
So, it has been studied and observed that the roughness sensation of woven fabric is less than the roughness sensation of knitted fabric. And the study carried out on nylon monofilament fabric of woven and knitted fabric.

So, perception of roughness increases with increase in filament diameter. So, as we increase the diameter of the monofilament, the perception of roughness will increase; that means, if we produce a fabric with a micro denier filament, another fabric with a

coarse monofilament, the coarse mono filament will give rough feeling. This is due to the various parameters it is a bending rigidity and all. So, ultimately the roughness is related with not only the surface roughness of fabric, but the many other parameters.

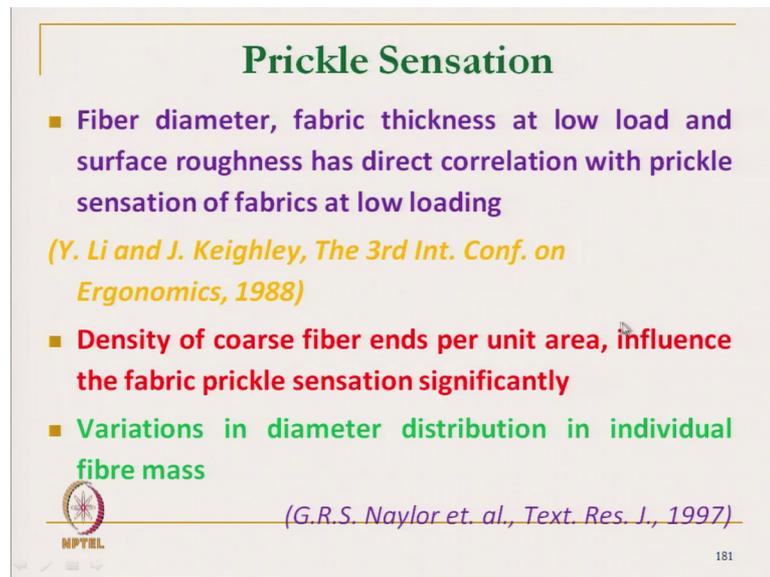
So, fiber diameter and also the knitted fabric the structure of fabric, it has been observed the knitted fabric gives the rough structure then the woven fabric. So, when fabric due to it is the proper structure, it gives the little bit less roughness then the knitted structure due to it is a loose structure.

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This is the roughness sensation, it is a sensation received by subjective measurement, and fiber diameter. So, with the increase in fiber diameter, roughness sensors and increases and knitted fabric is rougher then the woven the as far as sensors and is concerned.

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Prickle Sensation

- **Fiber diameter, fabric thickness at low load and surface roughness has direct correlation with prickle sensation of fabrics at low loading**
(Y. Li and J. Keighley, The 3rd Int. Conf. on Ergonomics, 1988)
- **Density of coarse fiber ends per unit area, influence the fabric prickle sensation significantly**
- **Variations in diameter distribution in individual fibre mass**
(G.R.S. Naylor et. al., Text. Res. J., 1997)

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Now prickle sensation. Prickle sensation we have discussed a lot earlier how to measure the prickle sensation. Now the parameters; what are the parameters which affect the prickle sensation one study in 1988. It shows the fiber diameter, fabric thickness at low load; that means, amount of hair it measure. So, at low load that we have seen earlier, at low load and surface roughness, has directly correlated with the prickliness. So, higher roughness, higher fiber diameter and higher number of hairnets the fabric thickness measurement, it has got direct correlation with the fabric prickle sensation.

Another study which says the density of coarse fiber number of coarse fibers per unit area influence the fabric prickle sensation, that we have already discussed, co number of coarse fiber it is projected, and it is density if it is high, then it gives proper prickle sensation. So, variation in diameter distribution in individual fiber, that is very important. So, if a fabric is made of 100 percent at proper coarser fabric, coarser fiber, that will give a certain prickle sensation. But another fabric is made up of fiber of mix or diameter like, fine fiber coarse fiber mix.

If the diameter distribution that is a coefficient of variation of the fiber diameter if it is high, then that fabric will give us higher prickle sensation. That is the reason the wool fiber gives, a coarser wool fiber gives a higher prickle sensation, than coarser say any synthetic fiber. So, if we produce a fabric made of very coarse polyester or any other

synthetic fiber, coarse synthetic fiber, staple fiber where sufficient hairs are projected, another fabric made up the wool fiber coarse wool fiber.

So, the coarse wool fiber gives the more prickle sensor; due to the fact that wool being a natural fiber it does not have the same diameter. It has got the diameter variation it has got very coarse and finer also medium so that due to this variation the prickle sensation is more. Because the, if the all the fibers are coarser, then it does not mean that it will give the prickle is the more prickle. So, for polyester coarser fiber gives less prickle sensation than wool mainly due to the coefficient of variation of diameter. So, for polyester diameter variation is least.

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Fabric Scratchiness (Fabric Properties)

- The sensation of scratchiness is related to
 - Fabric tensile characteristics
 - breaking elongation; work of rupture ; and the modulus
 - Fabric surface roughness
 - frictional force, mean surface roughness coefficient, and deviation of surface roughness coefficient
 - Compressional characteristic
 - compressibility, linearity of the compression curve, compressional energy and slope of the compression-thickness curves of fabrics.

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Next comes the fabric scratchiness; it is again it is related with the frictional characteristics. So, it is related with the 5 fabric tensile characteristics. Breaking elongation, work of rupture and the modulus now try to see the same fabric, suppose same fiber we are using, one fabric is stretchable. We have developed a fabric or the coarse (Refer Time: 28:09) type of fabric; which is say stretchable in nature, and another fabric made of the same fiber which is not stretchable, or else we can see the woven fabric and are knitted fabric.

So, woven fabric is not that stretchable. Its elongation is not that high its modulus is high then the knitted fabric. Knitted fabric knitted fabric is stretchable in nature like in weft knitted fabric. So, web knitted fabric will give lesser scratchiness because of the

extensibility. Or if we use of fabric with higher extensibility, it will give less scratchiness. Fabric surface roughness; so, with the increase in surface roughness; obviously, it will give scratchiness.

Frictional force, mean surface roughness coefficient and deviation of surface roughness coefficient this all give the sensation of scratchiness Compressional characteristics that as we have discussed earlier also that roughness the scratchiness also a fabric with very highly rough structure. But highly compressible may not give the scratchiness so, that so these are all related. Compressibility linearity with compression; so, all this parameter are related with the scratchiness.

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Fabric Scratchiness (Fibre Properties)

- **The fabric scratchiness sensation is influenced by the**
 - **Flexural rigidity of fibre**
 - **Friction characteristics of fibre**

- **The flexural rigidity of fibre is dependent on**
 - **Fibre modulus**
 - **Cross-sectional shape**
 - **Linear density**
 - **Density**

which are influenced by polymer structure and orientation

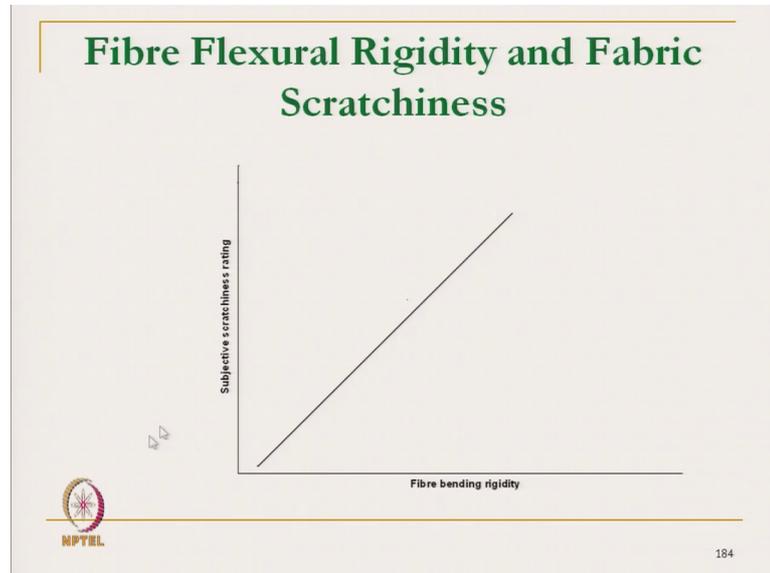
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So, there are the fiber properties which affect the scratchiness, and fabric properties which affect the scratchiness. The fiber properties are the fabric scratchiness depends on the fiber properties which is flexural rigidity of fabric. So, higher flexural rigidity will give higher scratchiness. So, we need a fabric fiber with a very soft fiber. So, to reduce the flexural rigidity we can use the fiber diameter simple so that way it will give less scratchiness.

So, that is why coarser fiber always keep scratchy feeling then the fine of a program. Frictional characteristics of fiber; so, fiber friction characteristic we up to use of fiber with less frictional coefficient. So, flexural rigidity of fiber it is dependent on the fiber modulus, cross sectional safe, linear density and density of them.

So, this density is related with it is a polymer characteristics. So, this and fiber modulus is also for polymer characteristics. So, if we change this if we can control this flexibility we can control the fiber scratchiness.

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So, fiber flexural rigidity and fabric scratchiness they are actually directly related; with a straight, very actually very highly correlated with this scratchiness sensation. So, higher flexural relative will give you higher scratchiness sensation.

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Fabric Scratchiness ... cont

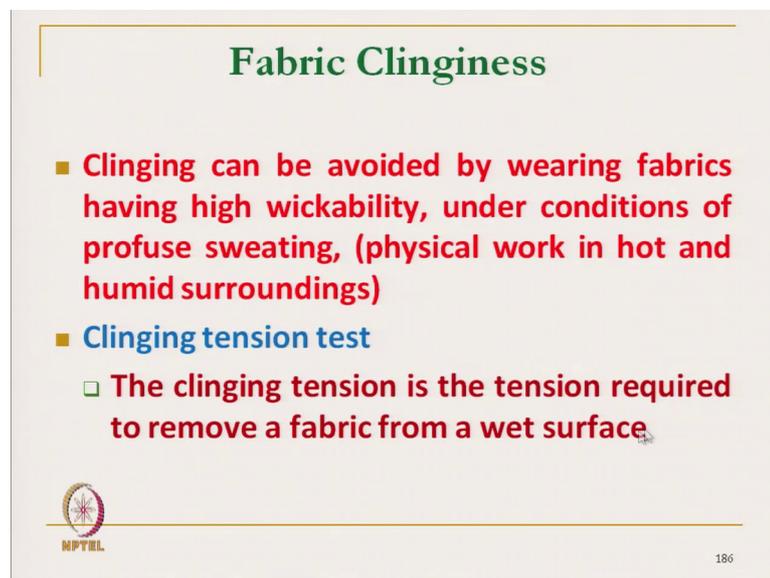
- Higher friction gives higher scratchiness
- Fibres with lower friction (e.g. nylon and rayon) show lower scratchiness than predicted from the flexural rigidity

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Higher friction gives higher scratchiness. Fiber with low friction like in nylon or rayon; this nylon and rayon they give they have the low friction it is so, lower scratchiness than predicted from the flexural rigidity. So, if we predict the; if we use the scratchiness as a function of flexural rigidity, then nylon gives a lower value, because of the it is a lower friction. So, friction so, it is a related with the friction flexural rigidity, diameter of the fiber so, that if we understand this parameter then you can control the fabric specimacy.

So, if you have a problem with tactile sensation of higher scratchiness, then we can control with all these parameters. Next comes another feeling, uncomfortable feeling which is clinginess.

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Fabric Clinginess

- **Clinging can be avoided by wearing fabrics having high wickability, under conditions of profuse sweating, (physical work in hot and humid surroundings)**
- **Clinging tension test**
 - **The clinging tension is the tension required to remove a fabric from a wet surface**

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The clinginess it is a nature which actually it is a fabric tries to stick to our skin. And fabric only sticks to our skin when our skin is wet; that means a fabric which is comfortable in this cold and dry temperature may not be comfortable in hot humid temperature.

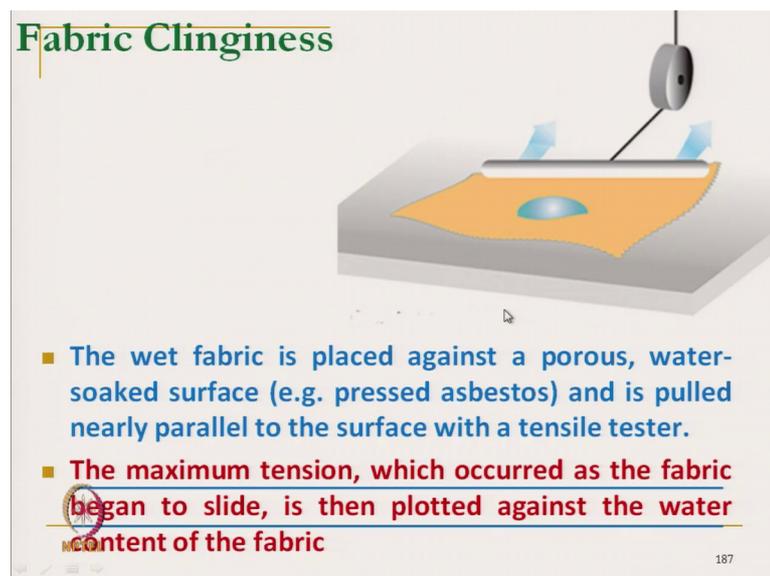
So, we must understand the what is clinginess, and how to eliminate by selecting the fiber characteristics. So, clinginess can be avoided by wearing fabric having high wickability. So, if the sweat whatever sweat it is coming out from the body, if our fabric is able to weak to absorbed and weak the all this take our take away the sweat and make the skin dry, then that will not have this clinginess, under condition of profuse sweating.

So, when person work it is a work ware for a particular work ware so, in hot and humid surrounding. That type of condition if its fabric tendency will be to clean with this body, and then it gives them different tack tail sensation which is uncomfortable in nature.

So, for work where we should be very careful about the clinginess characteristics and that means, we have to use a cloth we have to use a fiber which is very highly weaking characteristics. And clinginess tests we can do to actually it to be measure the amount of clinginess feeling of the fabric. It is the clinginess tension required to remove of fabric from a weight surface.

In a weight surface of fabric is there. So, in this table if you pour water then a fabric is placed in that and how much force is required to take away the fabric it is a clinginess tension.

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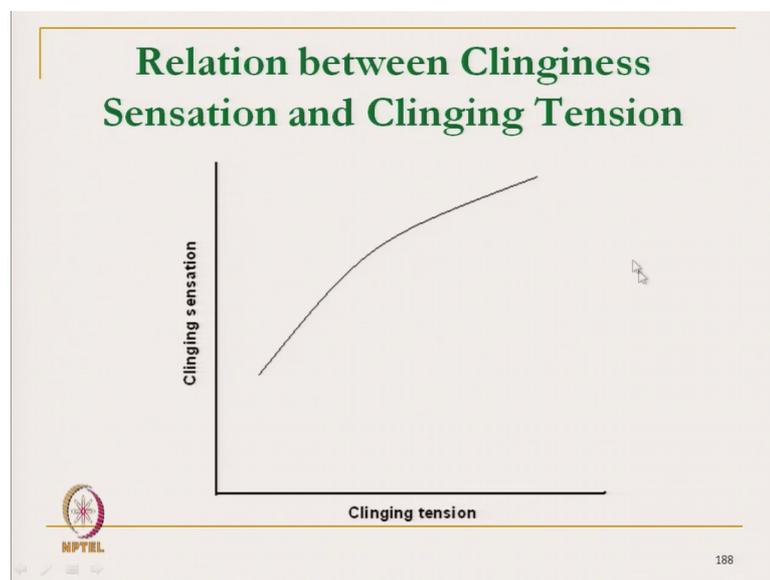
So, this is measured with this principle. Now this is the surface, and this yellow one is the fabric one, and it is water is placed. The weight fabric is placed against the porous in a water soft surface. This is the porous and water soft surface, and it is pulled nearly parallel to the surface and then the tension is measured. So, with the help of tensile texture, it is a very simple test.

But this gives an idea about the clinginess characteristics. The maximum tension which occurred at the fabric when it begins to slide and that is the clinginess tensile; is plotted

against the water content of the fabric. So, you we you keep on changing the water content, and then we try to measure the tension. So, that gives an idea about the different at different level of sweating, what will be the clinginess testing?

Now, hear this we can take our, actually our hand our body surface as a another surface is this surface, we can. So, this one can easily develop this instrument, and one can test the different level of sweating what will be the clinginess tension for different types of fabric.

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So, this is the relations between the clinginess sensation and clinginess tension. So, this is there is a very good correlation between these 2 parameters.

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Fabric Clinginess

- **The lower the flexural rigidity of fibre the greater is the clinginess**
- It may be due to a lesser ability of the fibres to break up the water film causing adhesion between fabric and skin

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So, what are the various factors which affect the clinginess? So, lower flexural rigidity of fiber gives greater clinginess; that means, if we use not only fiber it is yarn also or it is also fabric. So, if we use a fiber with a highly flexible fiber or maybe one is a coarse fiber and others fine fiber.

So, coarse fiber will have lower flexural rigidity, and that will give us more clinginess. That means, it will try to actually take it is the safe of the surface, and when it is a cleaned what is a weight it will try to stick to the surface. So, it may be due to the so, the lower flexural rigidity means it is may be due to a lesser ability of fiber to break up the water film caused by addition between fabric and the skin.

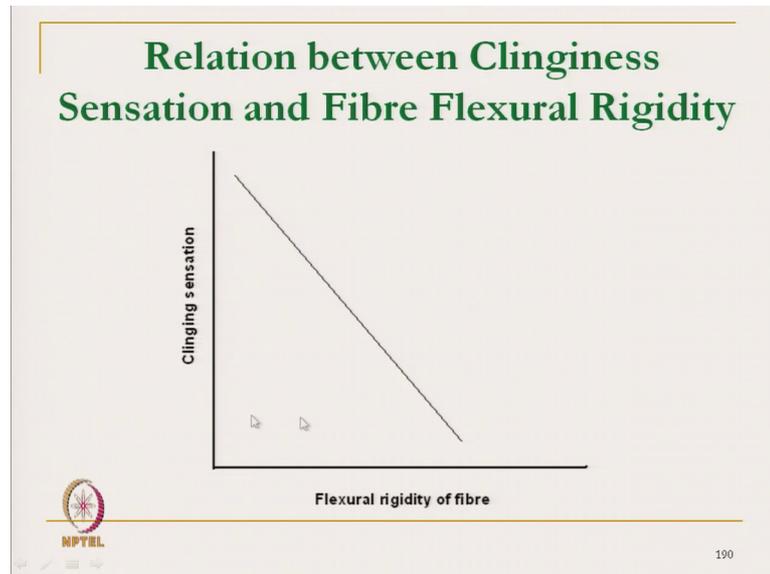
So, this when the sweat is present in our body on the skin so, it will form a film water film, and it will form a bond with the skin and the fabric. The lower flexural rigidity means it will try it has it does not have that much force to break this the bond. So, if instead if we use the higher flexural rigidity, whatever born it is trying to form due to it is rigidity it will try to break.

So, that means, the fabric very soft fabric very highly flexible fabric always give this type of problem of clinginess. So, that we can in our daily experience we have seen if we were very fine fabric made of cotton see, very fine fabric, it gives the it tries to stick to it is a clinging force. So, that type of sensors and we may not get if we were a coarser of

fabric. And this clinginess we do not get that filling in the dry condition, dry and cold and dry condition. Only the problem comes in hot and humid condition.

So, this the water film can be broken by using the fiber with higher flexural rigidity.

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So, the relationship you can see the higher flexural rigidity keeps the lower clinginess clinging intense. Next comes the warmness and heaviness; s, warmness and heaviness is another tactile sensation which we receive; it is a combination.

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Warmness and Heaviness

- Fabric warmness and heaviness also cause discomfort
- The rating of the tactile sensation of heaviness **alone is very low**
- Since heaviness is related to warmness, the two sensations have been combined (**in AC room heavier cloth does not cause discomfort**)

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It is a very highly uncomfortable sensation. The fabric warmness and heaviness, it is it is not the separate you cannot separate the warmness and heaviness, it is a combined. This sensation is very highly disturbs it is gives discomfort.

The rating of tactile sensation of heaviness alone is very low. Alone heaviness is it is tactile sensation is low; like the heaviness is always associated with the warmness. And to sensation have been always combined like heavy fabric like with higher GSM higher mass, heavier cloth we are wearing at air conditioned room that we may not feel that much discomfort.

But the same fabric will be highly uncomfortable when it is warm and humid. It is at high temperature it is warm temperature that heaviness of the fabric it gives different types of sensation; it is a tactile sensation. So, that means, warmness is associated with the heaviness. So, heavy fabrics we can always use at cold temperature. But at warm temperature, whatever may be the condition the fabric always you should try to develop a fabric with lighter fabric, lighter in mass then only it will give comfort. Otherwise we will get a combined sensation of tactile sensation which is a discomfort able sensation.

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Warmness and Heaviness

- **Warmness** might be more dependent on **fabric thickness** than on weight
- **Heaviness** might be more dependent on **weight than on thickness**
- **The product of fabric weight and fabric thickness was a better objective measurement for correlation with warmness and heaviness than either weight or thickness alone**

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So, warmness might be more dependent on fabric thickness. So, our thicker fabric will give more warmth than its weight. So, weight fabric may be heavier, it may not be warm. So, a thick fabric will always give the warmness. So, you have to now the sensation of warmness and heaviness we have to measure, how to measure the warmness of and

warmness and heaviness sensation. So, first if we want to measure the, get the idea about the warmness, we should measure the thickness. And if we want to measure the heaviness of the fabric, it is more dependent on the weight of the fabric than thickness.

So, we will measure the thickness and weight of the fabric. So and when we are talking about the warmness and heaviness, they are interrelated; then we have to have certain parameter, which is product of fabric weight and fabric thickness. So, we can if we get a parameter which is product of fabric weight and fabric thickness, which will give an idea about the warmness and discomfort about related to warmness and heaviness.

So, this product it gives better idea the objective value about the sensation of warmness and heaviness. The discomfort due to warmness and heaviness, it is highly correlated with that this product. Now, we have discussed all these aspects of the tactile sensation and fabric handle related characteristics roughness, scratchiness, smoothness all these characteristics we have discussed. And basically this all these characteristics are actually, it can be improved by fabric finishing.

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Finishing

“Cloth is made in the Finishing”

- **There are many finishing treatments, namely**
 - **silicon finish**
 - **nano-finish**
 - **brushing etc.**

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So, it is said that cloth is made in the finishing. So, whatever may be the characteristics we are, if we want to say make the fabric reduce the fabric friction or improve the fabric surface roughness we can finish the fabric.

If we want to make the fabric smooth, a fabric flexible we can finish. Finishing may be chemical finishing may be mechanical finishing. So, whatever fabric we are producing, if we feel the tactile sensation tactile finish tactile comfort is not achieved, then we can incorporate of extra finishing. If we have; if we feel that a fabric is not that much soft we can give the softness finishing if we feel the fabric is not that compressible we can give we can also improve the compressible finishing.

So, finish fabric finally, is made in the finishing for improving the tactile sensation for improving the comfort. So, there are many types of finishes available we are not they will not discuss here. So, we can improve say compressively characteristics we can improve the warmth by brushing.

We can improve the softness characteristics by various characters a various finish. So, if we understand all these parameters, if we understand the effect of fiber characteristics, effect of fabric characteristics, effect of finish characteristics on the tactile sensation, then we can develop a fabric with very highly comfortable fabric for as far as tactile comfort is concerned. So, with this we will end the session of tactile sensation.

Thank you.