**Science of Clothing Comfort**
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**Lecture - 39**
**Garment Fit & Comfort**

Hello everyone. So, we have reached to the last section of our course Clothing Comfort. In this segment, we will discuss the comfort related aspects of Garment Fit. Now, garment fit ultimately whatever we produce with select fiber, perfect fiber we select, then perfect yarn we can produce, perfect fabric we can produce for a specific condition, specific activity level or specific environmental condition, but if we cannot develop the finish product right finished product with perfect fit, then our total effort of fiber production, yarn production, fabric production will go as.

So, garment fit is extremely important which actually gives, which gives a final product and it is directly related with our comfort. So, here we will discuss the issues related with the Garment Fit.

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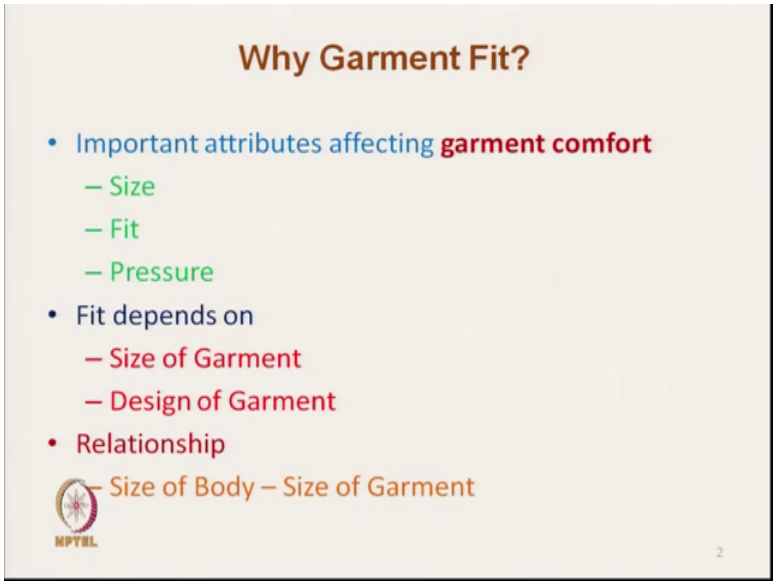


Now, first let us try to understand why garment fit, what is the importance of garment fit and how are these factors control the comfort sensation. The important attributes affecting the garment related comfort is the size of the garment whether is a loose or it is tight. It is the fit of the garment, how well it is actually covering our body, how well the

fabric is, how uniform uniformly the fabrics are in touch with our body, how much pressure it is exerting on our body.

So, all these things are related with the garment fit and these are actually, these are the factors which govern the garment related comfort. Here our assumptions is that our fabric which you have got cloth which you have got it is perfect, perfect for comfort, perfect as far as the tactile sensation is concerned, perfect as far as the heat transmission is concerned, perfect as per as moisture transmission is concerned. Now, the fit of garment depends on the size of garment and designer garment and these are the, there is a relationship between the size of body and size of garments. There has to be correlation between the size of body and size of garment, so that if we can maintain all this, then we can ultimately achieve the comfort. So, perfect fabric cannot give, cannot incorporate or cannot produce perfect comfortable clothing if we do not consider that fit as an important factor there.

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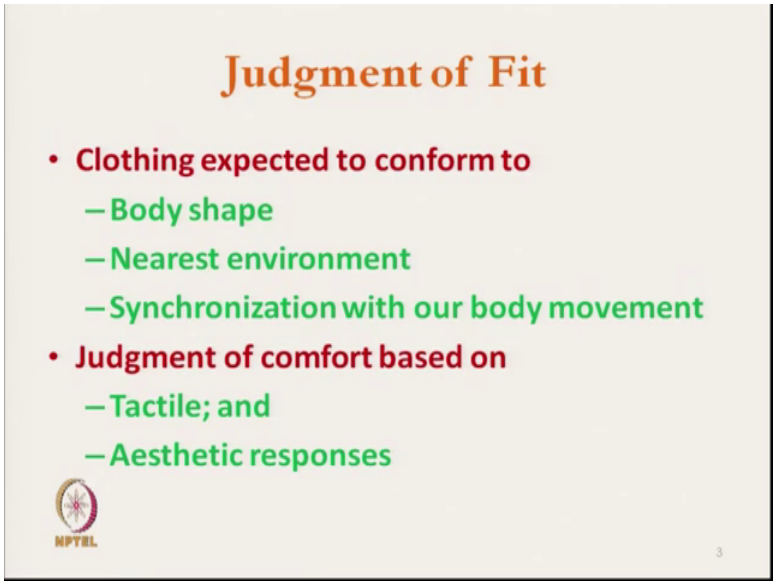


So, how to charge the fit? So, clothing is expected to confirm our body shape. That means, if we are if we develop a clothing, if we actually stitch a clothing which actually does not confirm our body shape ok, so that will give us the discomfort sensation and that in that case, body will not, it is not of good fit if it is a less than our body size. That means that will give that will either not fit inner to our body or it will unnecessary exert pressure on our body and its nearest environment which are always in touch with our

body and third one is that it should to be able to synchronize with our body movement. If it restrict our body movement, then you will feel uncomfortable.

In that case, we will not tell that the fabric is a good fit. So, based on this fit judgment, ultimately we will have two types of comfort mainly. As far as fit is concerned, it is a tactile comfort which is always sensation of touch as we have discussed and aesthetic comfort.

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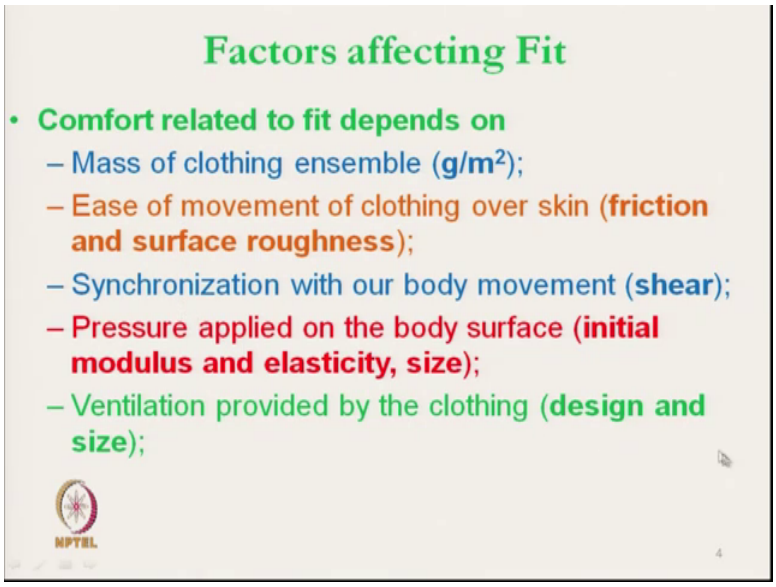


So, the comfort related to fit depends on the mass of the clothing. What is the, what the total mass of the clothing? It is ease of movement of the clothing over skin that is surface friction and surface roughness synchronization with our body movement that is shear. If I am moving my hand, the clothing has to confirm this change in my posture and that take place with the, that is due to the shear characteristics of the clothing. If a fabric is made of clothing is made of a fabric with high shear resistance, that will give us uncomfortable, but and if the surface roughness is high, that will give us uncomfortable in nature.

If the fabric mass is high that will give us the uncomfortable nature and the pressure exerted on the body surface design. Now, these are the parameters like mass of the clothing, it is not in our control. If we talk about only fit friction and surface roughness, we cannot always expect the fabric will be of proper friction and surface garment sometime if we want to have a fabric with higher thermal insulation, if our requirement

is of higher thermal insulation, if our requirement is of very thick fabric, mass per unit area will be high. The roughness sometime we require and sometime we may require of fabric with very stiff in nature like coated fabric.

A coated fabric sometime required for it is a protective clothing and in that case, here rigidity will be very high. That will not confirm our body movements, it will not be synchronized with our body movement and we have the fabric and we need to use that fabric for some specific purposes like for example, for firefighter clothing or for some any others protective clothing. We may have to use of clothing with higher mass per unit area, higher friction or surface roughness may be higher, shear rigidity and sometime we may have to have a fabric with higher pressure depending on the like swimmer suit.

So, higher pressure is required. So, if we have to use this fabric and if we want to incorporate the comfort, in that case only thing we can do by adjusting the fit of the clothing here, fit is important. Very commonly we have seen that it is for say protective clothing we have higher mass, higher roughness, higher shear rigidity. We always try to use of fabric, develop a clothing of loose in nature because it should not restrict our body movement,. It should not have actually the higher fiction with the skin and the mass per unit area is actually related with the warmth of the cloth.

We have discussed earlier also, so that if we can take care of this by controlling the fabric fit, you will be able to incorporate the comfort and by adjusting the fabric fit, we can provide the ventilation in the clothing. If we can provide the ventilation, proper ventilation, all these above factors will be minimized as per as comfort is concerned,.

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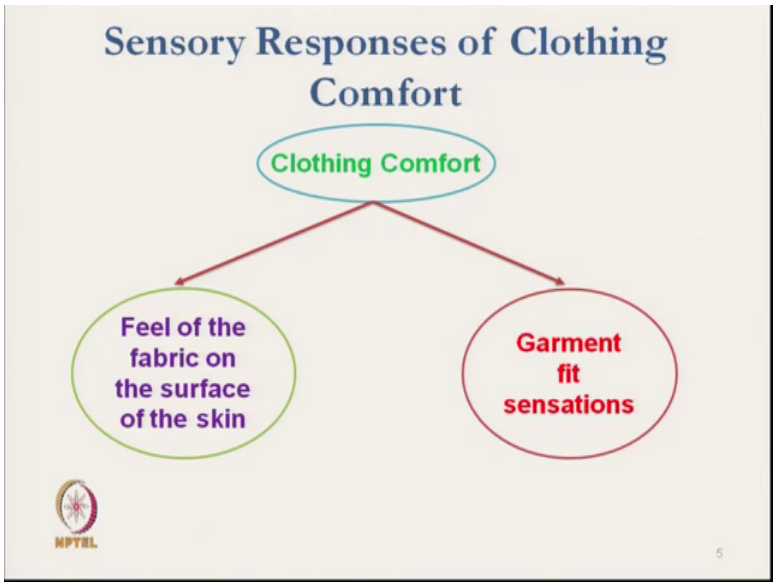


So, the sensory response of clothing comfort is feel of the fabric on the surface of the skin. That is one aspect as we have just discussed and another is the garment fit sensation. That means, if we can change the fit change, the actually make it loose fit or make it tight fit, that sensation is also important.

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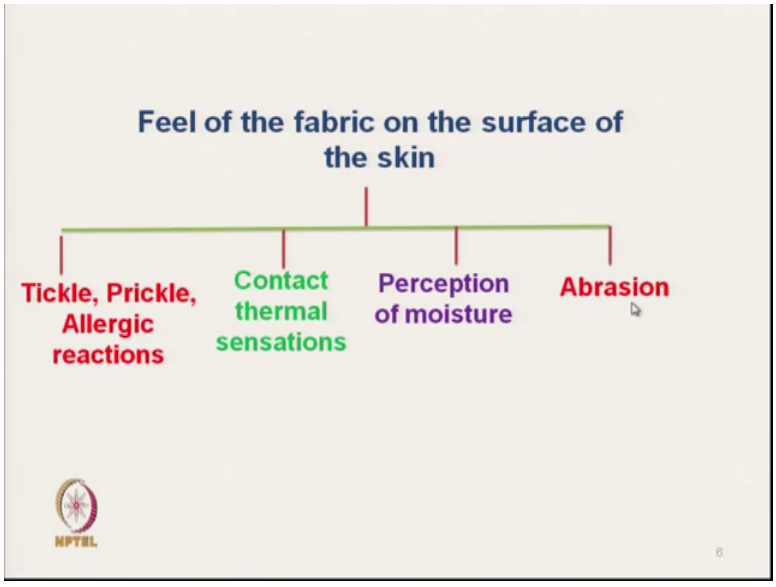


This part we have discussed with this is with the skin surface tactile sensation. This contact thermal sensation, perception of moisture, abrasion, these are the things we have already discussed here earlier.

Now, we will discuss only with related to the garment fit.

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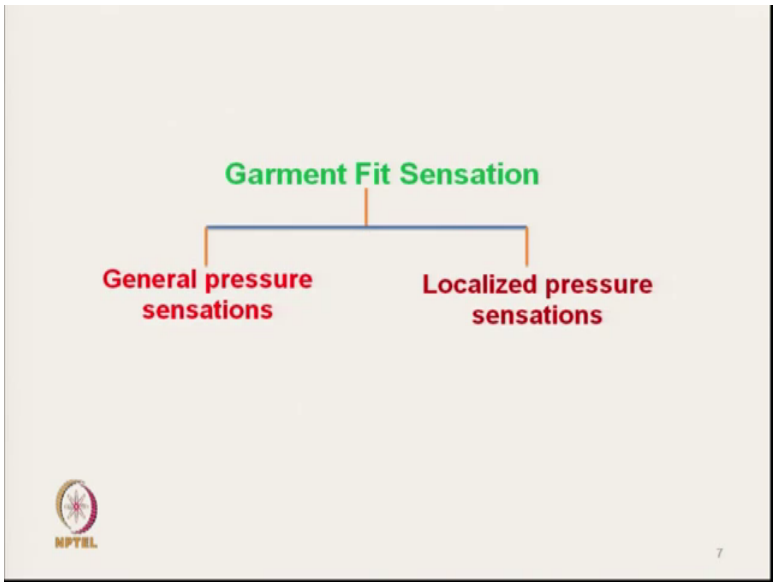


So, garment fit if we consider here, it is two aspects. One is overall pressure, general pressure sensation of the body and another is localized pressure sensation. It actually it applies the pressure at certain body parts. So, these two sensations are important which are related with the garment fit.

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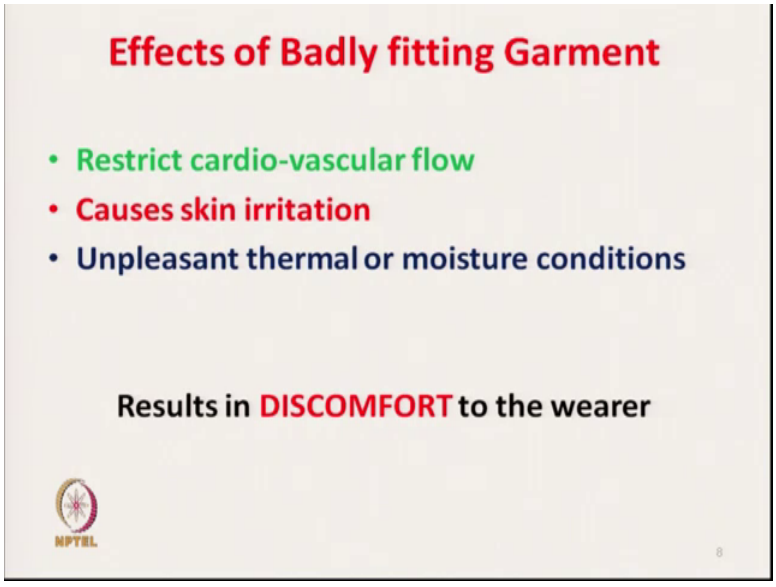


So, what are the effect of badly fitted garment? So, how this badly fitted garment effect our comfort sensation? So, it restricts cardio vascular flow if it is very tight. So, it will

actually restrict our cardio vascular flow causes skin irritation. So, fabric with rough surface if we produce a clothing of tight fit, then it will give a sensation of irritation, unpleasant thermal and moisture condition sometime it creates a if we can control the microclimate condition. So, it results overall discomfort.

So, this all this we can control by fit, proper fit. All the negative aspects of clothing fabric we can to some extent eliminate in by proper designing of clothing and by proper selection of fabric fit. So, to design a clothing of proper fit, either requirement as per requirement loose fit, tight fit. So, we should know the body dimension and the pattern. We are not going to discuss pattern here in detail, but as pattern is related with the garment fit, we should just try to see what are the challenges in pattern making and fit fitting of garment. Most basic pattern also required complex decision related to dimension.

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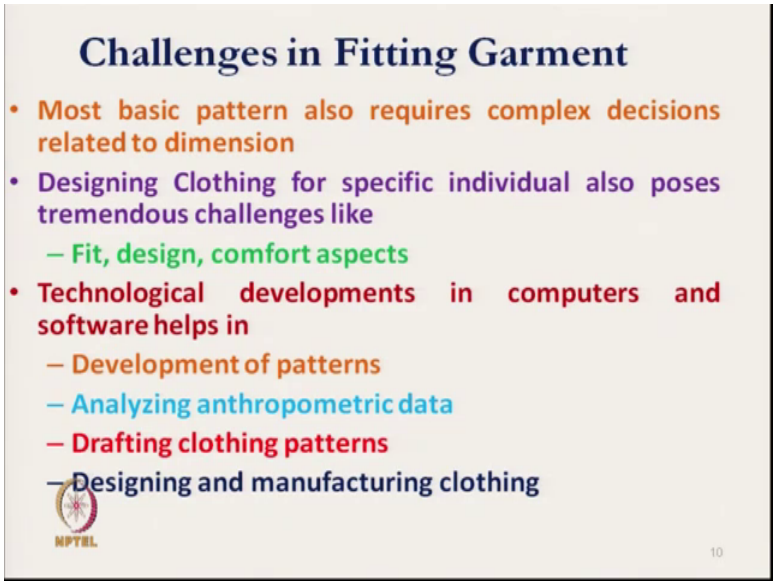


So, it is not that simple. What in the designing clothing for specific individual also pose tremendous challenge challenges, the fit design and comfort aspects? So, simple designing of clothing is it is not that simple. So, fit design and comfort aspects we have to see some. Now, the technological developments in computer and software helps in developing pattern, analyzing anthropometric data and drafting clothing pattern and designing and manufacturing cloth. These are the things which software can help us.

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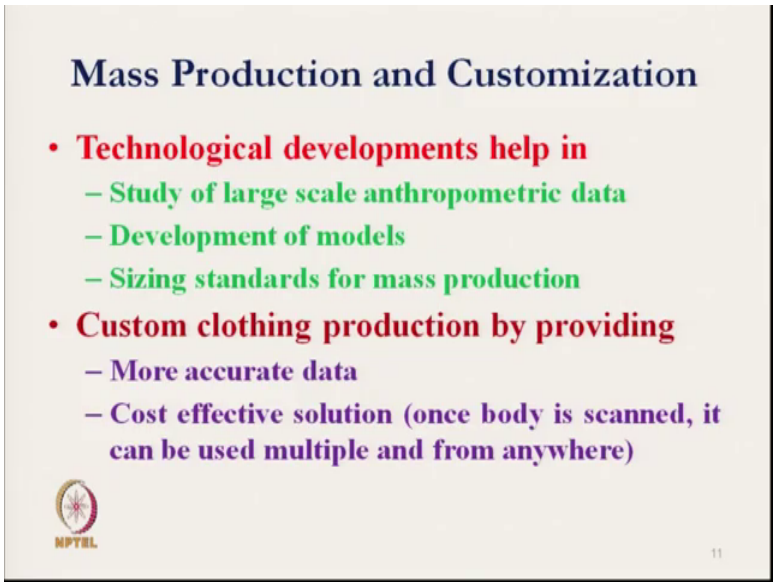


But ultimately the pattern it is not that easy, ok. So, technological development helps in study of large scale anthropometric data development of models sizing material for mass production. So, this a for mass production. So, anthropometric data can be taken from the particular population and clothing can be designed, ok. This is one aspect which is actual at presently it is available.

So, if we go to any shop, we can just take the particular size of the garment and that may fit. It is depending on the data. Its mass data has been taken. Generally it fits to us, but sometime custom made clothing is produced and it is more accurate and advantage is that it is a cost effective solution. So, once my body scanned data is taken and it can be multiplied, so if the my body dimension is taken if it is stored and then, automatically that is can be reproduced.

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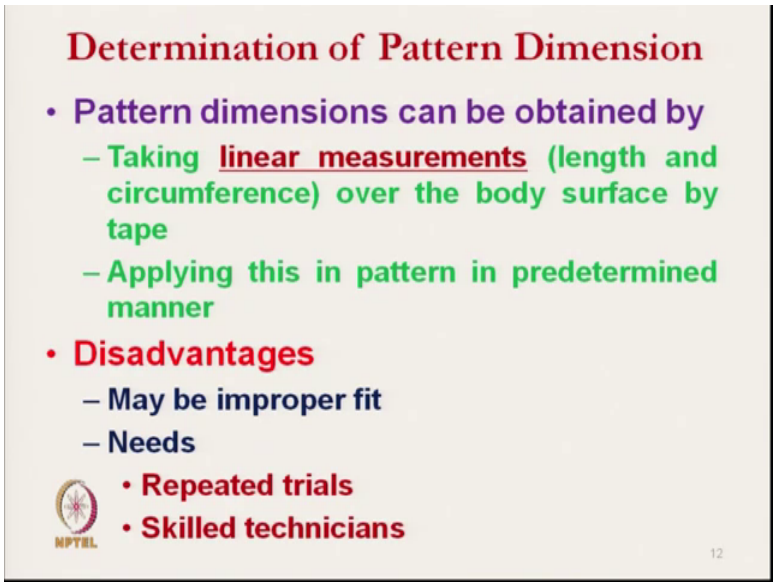


So, pattern dimensions can be obtained by taking, it is a normal, it is normally we do it is taking linear measurement length circumference of a body part applying this pattern in predetermined manner, so that we can use we can develop our clothing. So, it is basically main disadvantage is that it needs a skilled technician, ok. So, it may it is not everyone cannot do from a linear dimension to convert it your garment.

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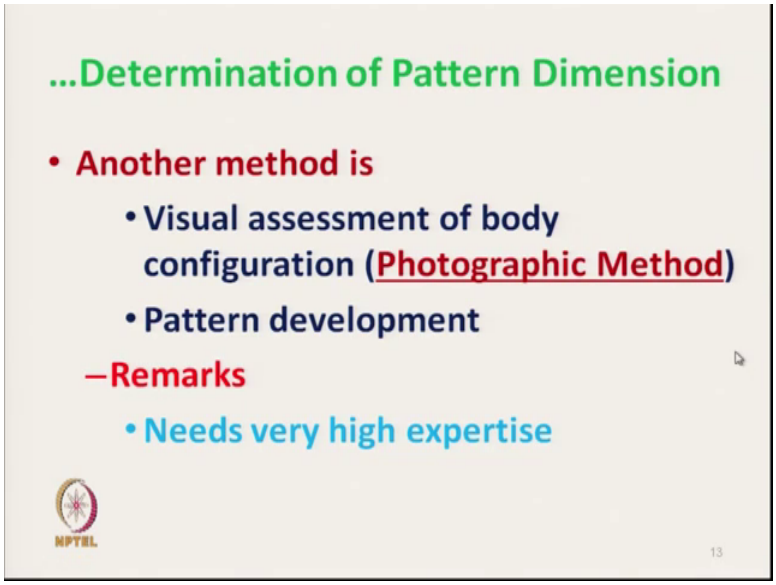


Another method is the visual assessment of body configuration photographic method. From there one can develop clothing pattern and it needs high expertise. So, two

methods of, one is a linear measurement of pattern and another is the photographic method.

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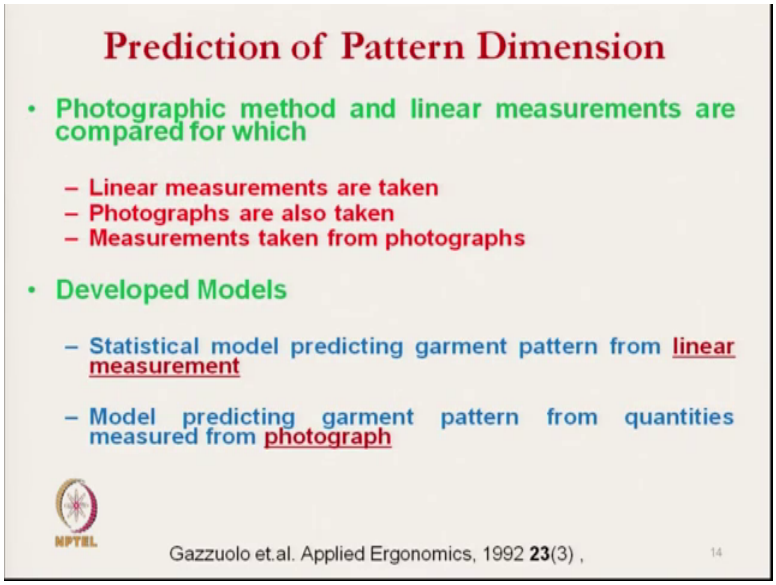


So, photographic method and linear measurement one can get the correlation. So, from there one can develop a pattern.

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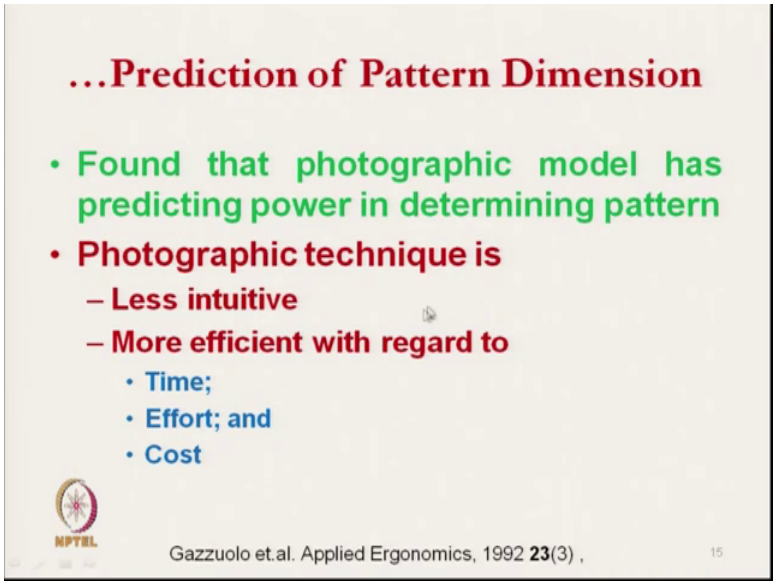


So, it was found that photographic model as predicting power in determining the pattern. So, photographic model is a, it is a less intuitive more effective with regard to time,

effort and cost. So, it is proposed that photographic method can be applied,. Now, we will see how the garment fit is related with the comfort sensation?

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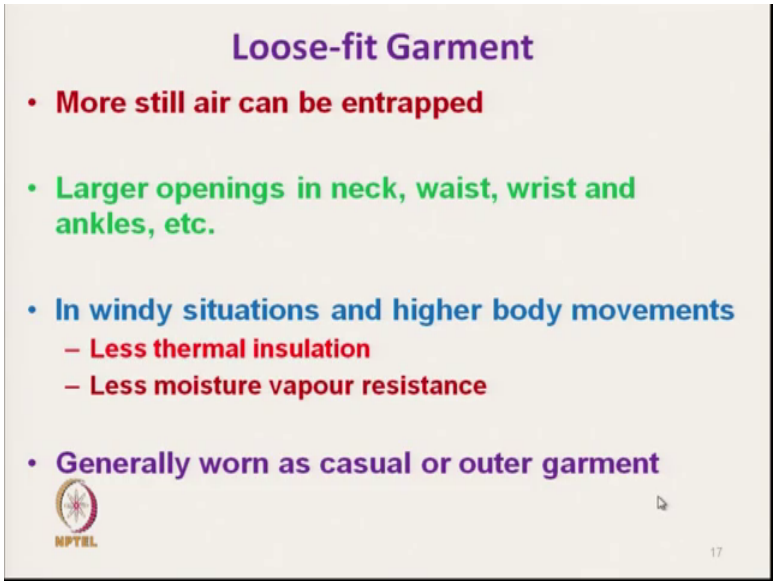


So, Loose-Fit Garment, if the garment is of loose fit in nature, it entraps more still air. So, more still air entrapment means the microclimate is filled with the still air. It will have higher insulation, large opening in neck, waist, wrist and ankle. So, loose fit garment if it is there, if we can cover this let us say it is if it is opening, so that means proper high ventilation will be there in windy situation or in higher body movement this will create total below effect. So, that will reduce the thermal insulation, less moisture vapour resistance because moisture vapour will not actually pass through the fabric, it will try to get escaped from through the openings at neck, waist, wrist and ankle this position and it generally it is worn as casual or outer garment. So, loose fit garment is.

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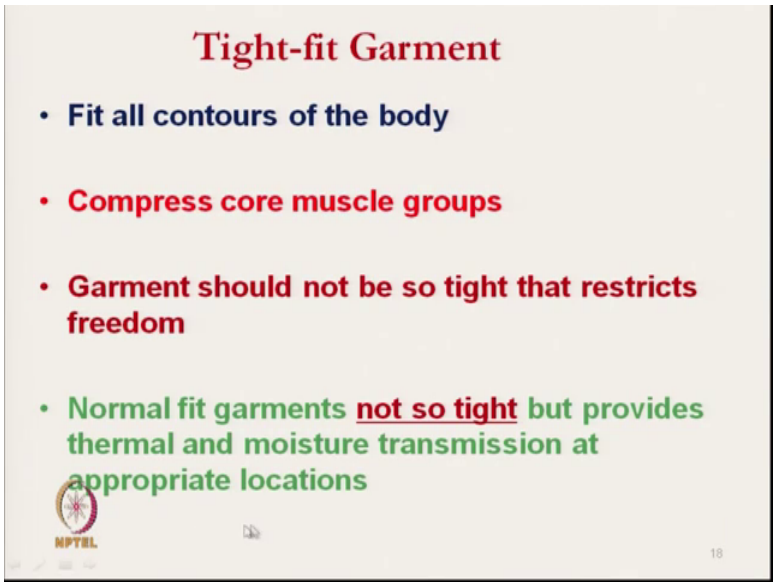


Now coming to the Tight-Fit Garment; here the issue of thermal transmission and moisture vapour transmission is there, but in addition to that it start applying pressure on our body. So, garment pressure is also there. It fit all the contour of our body and it touches all the contour of our body. So, tight fit garment we can see any tight fit garment like a swimwear, it is a tight fit garment compresses core muscle groups. So, it a it compresses the muscle. Garment should not be so tight that it restricts freedom. So, if we consider in the garment is made of a oven fabric. So, and tight fit garment it will definitely restrict our body movement because the oven fabric made up normally yarn is not that expensive yarn.

So, normal fit garment not so tight, but provide thermal and moisture transmission at appropriate location. So, that is this type of garment is important.

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This is the Loose-Fit Garment for outer jacket and Tight-Fit Garment just it gives the body contour.

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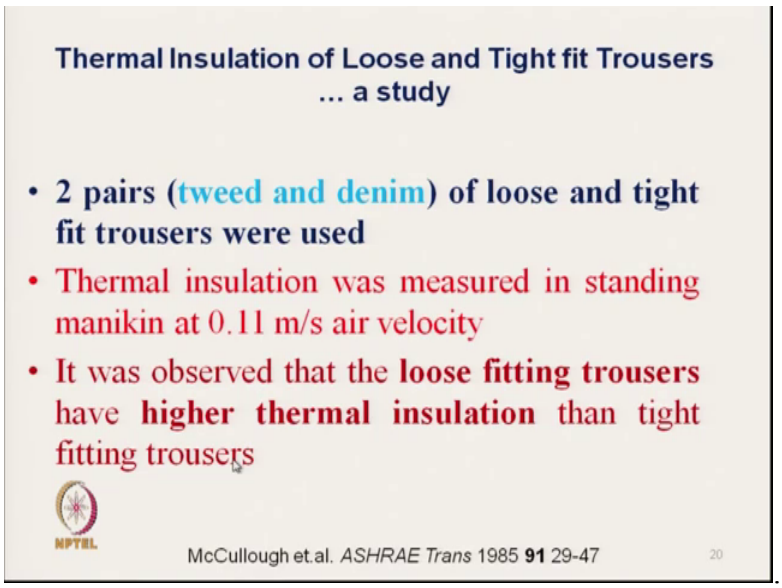


Now, try to see couple of studies. In one of the studies, two pairs of clothing were taken. One is made up of tweed, another made up of denim and their one is loose fit, another is tight fit and their trouser are made and thermal insulation was measured in standing manikin. So, manikin standing condition it is measured at certain air velocity. So, what it is observed that the loose fit trouser having higher thermal insulation, then tight fit

trouser because the manikin is standing. The still air is interruptted more in case of loose fit garment.

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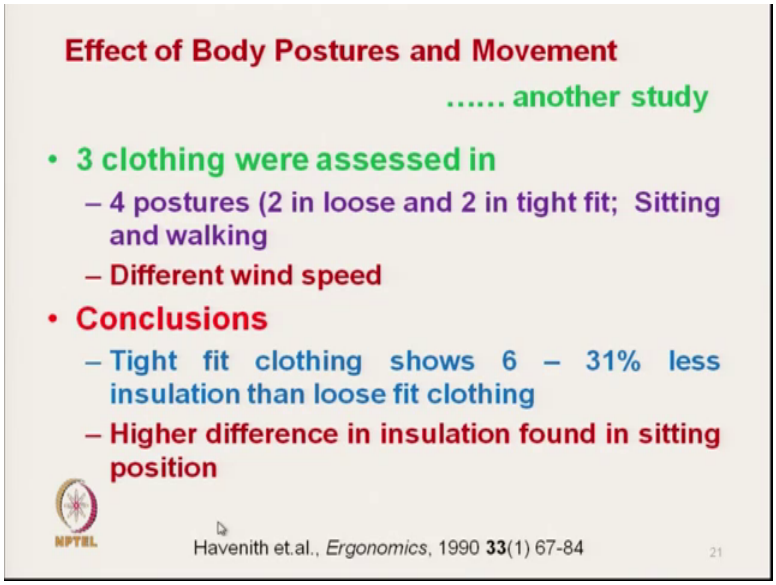


In another study 3 different clothing's were taken [noise, 4 different postures, 2 for loose fit and 2 for tight fit and walking and sitting, sitting and walking condition, loose fit and tight fit and the study was carried out at different wind speed, but observation they have found they concluded the tight fit clothing shows 6 to 31 percent less insulation than loose fit clothing when it is basically sitting, in sitting condition, the tight fit clothing give less insulation.

Higher difference in insulation found in sitting position;. That means, when in a sitting position, a tight fit and loose fit the differences approximate 31 percent, but when he is walking, the difference drop down to 6 percent which means that loose fit garment is not giving that insulation when he is walking, walking due to ventilation and bellow effect also and lower difference in walking and in presence of wind.

So, Different Wind Speed, at the higher different higher wind speed, the difference between the tight fit and loose fit become less. In walking condition, the difference between tight fit and loose fit is less and in sitting condition it is very high, ok. So, a person is sitting idle with the less wind speed will give with the loose fit garment will give in warm. That means, in cold climate a person if he is wearing a loose fit garment and sitting in a rest position, you will feel warmth.

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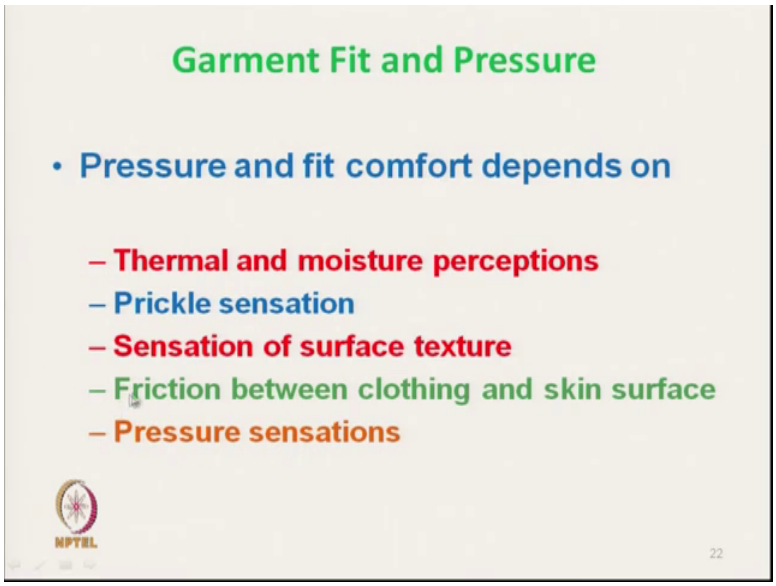


Now, coming to the another aspect. It is a pressure that is it depends on the pressure and fit related comfort is also dependent on the thermal and moisture perception. If it is hot and humid climate even a small increase in pressure give us discomfort sensation, but in a air condition cold and dry humid dry condition even if the pressure is I will may not feel that much discomfort sensation. It is related to the touch and pressure sensation.

So, for warm humid condition if we wear tight fit garment, we may feel uncomfortable. Prickle sensation will start as we have discussed earlier because hot and humid climate tight fit garment will give us prickle sensation. Same fabric if we have to wear to reduce the prickle sensation, if we make it loose fit garment it will prickle sensation will to some extent reduce sensation of surface texture that means, pressure sensation that if the surface is rough and rough fabric. If it gives higher pressure, it will give discomfort sensation. Friction between clothing and skin; if it is tight fit, it will give us the discomfort sensation and obviously, the pressure sensation and this pressure sensation are related to all these factors.

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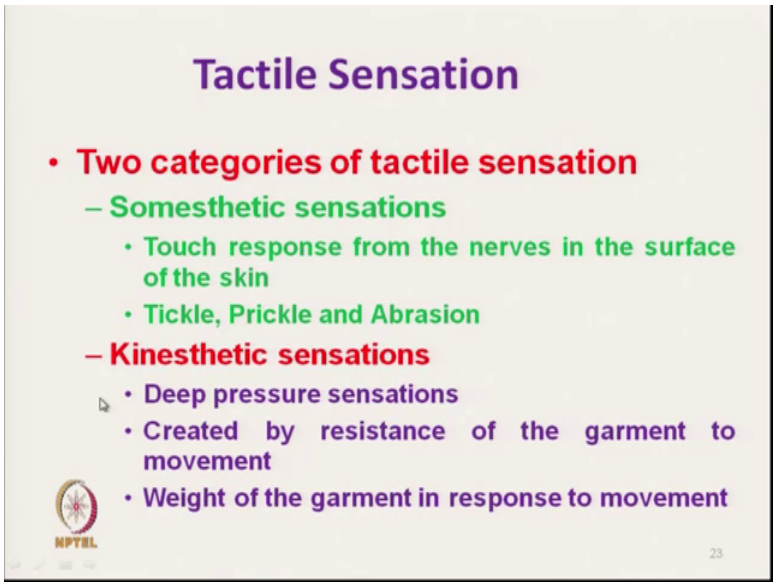


So, there are basically two categories of tactile sensation. One is somesthetic sensation touch response from the nerve in the surface of the skin that we have already discussed tickle, prickle, abrasion sensation. Another is that kinesthetic sensation, the deep pressure, deep pressure sensation and this is actually related with the garment fit. So, although that this touch response sensation related with the garment fit, but kinesthetic sensation is directly related created by the resistance of the garment to movement.

So, if it is tight fit, so garment will not allow the body free movement of body weight of the garment in response to the movement.

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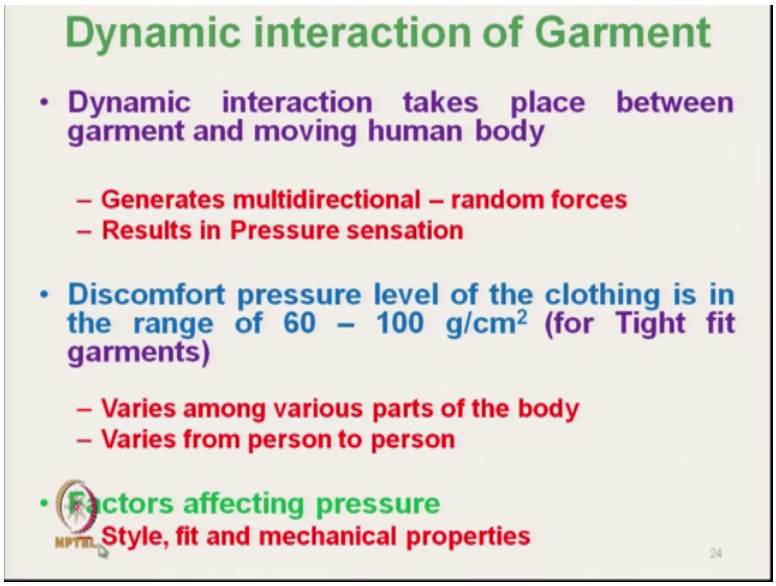


So, Dynamic Interaction of Garment is that it takes place during the movement of the human body and generates multi-directional force and which results pressure sensation. Now, overall for a tight fit garment if we see overall discomfort sensation, it starts from 60 to 100 gram per square centimeter pressure.

If a garment tight fit garment we are talking about tight fit because normal garment, the pressure range is different. We will discuss in normal garment it is around 25 gram per square centimeter and what we are trying here a tight fit garment, we are producing, we are actually wearing you know that the fabric will give us the pressure. It is pressure is required in that case even in that case, the pressure if it is increasing beyond 60, it will give us a discomfort sensation and it varies among various part of the body because 60 to 100 that is the range varies from person to person, ok.

If that range person will feel discomfort and the factors which affect the pressure is a style fit and mechanical properties of a fabric style we have discussed fit we have discuss and mechanical properties means the stretchability of the fabric. It is an elastic recovery of the fabric that we will actually directly affect the discomfort sensation of pressure. If a fabric is rigid in nature, it is not extensible. In that case, the pressure will be very high when we start our body movement.

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So, this is a typical example of range of pressure developed by different types of clothing's. Swimwear its 10 to 20 grams per square centimeter, Modern corsets 30 to 50, Knitted foundation garment 20 to 35.

So, these are the ranges of the pressures and if the pressure increases beyond that beyond 60, then we will feel discomfort due to the pressure.

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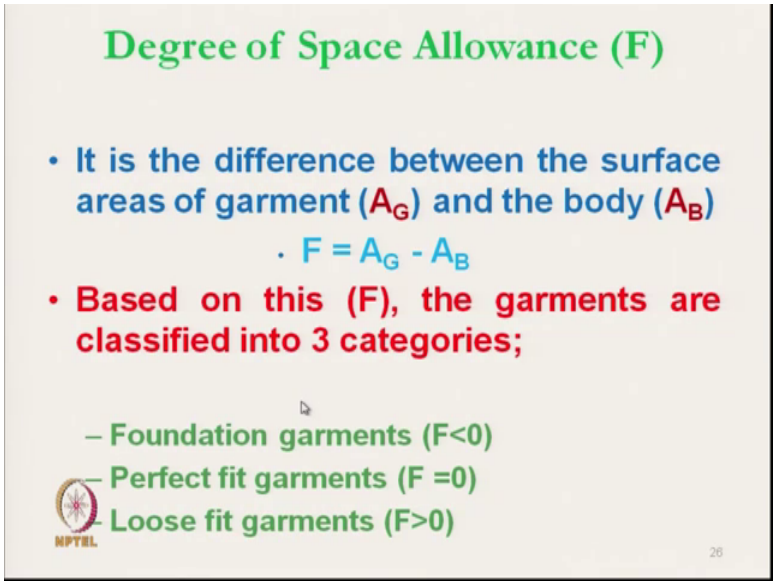


Now, if we want to reduce the pressure comfort, discomfort due to pressure, so we have to know the garment in relation size of the garment, in relation to our body and this

relationship is expressed in terms of degree of space allowance which is expressed in terms of F. So, what is that? It is the difference between the surface area of the garment and the body. If we take our total body area and take the total surface area in square meter, that difference is called Space Allowance. Its F is A G minus A B body area. It is a garment area and based on this F value degree of space allowance, the garments are classified into 3 categories. One is the Foundation Garrment where F is less than 0. That means, F is negative means A G is less than garments size is less than our body size which is used for foundation garment. That means, it is expected that the garment will insert pressure on our body. This is required like compression bandage or compression garment. So, it is actually meant for applying pressure in our body.

Next is the Perfect Fit Garment, where the body size is equal to the garment size and loose fit garment F mode. So, depending on the value of F degree of space allowance, one can predict the type of fabric type of pressure it will generate. So, foundation garment is known you know that loose fit garment is also it is known. Now, perfect fit garment if we develop a perfect fit garment F equal to 0, then it is up it is not that simple. It sometime creates problem in the sense if the fabric is not extensible, then it will restrict our body movement. Similarly foundation garment obviously fabric, this should be extensively used.

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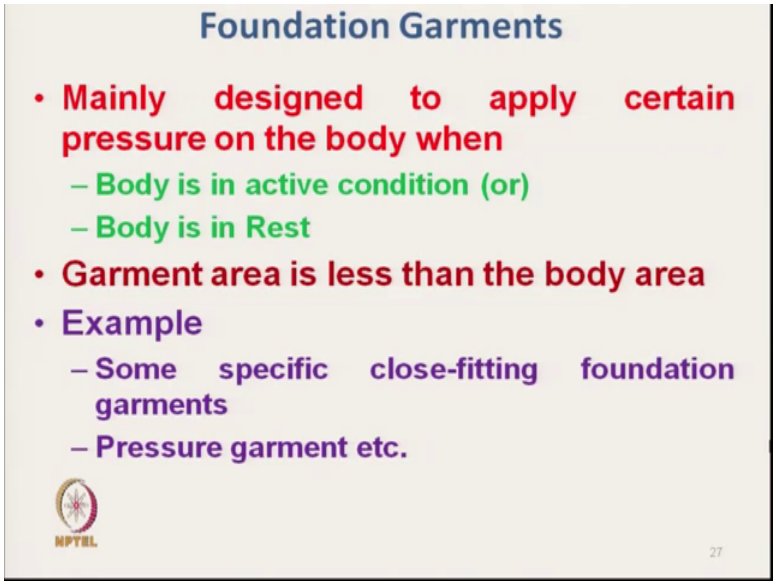

Now, Foundation Garment it is mainly designed to apply certain pressure on our body, when body is in active condition or body is in rest condition. So, it has some purpose for that the foundation garment is used and garment area is less than the body area that the example is that some specific close fitting foundation garment, pressure garment.

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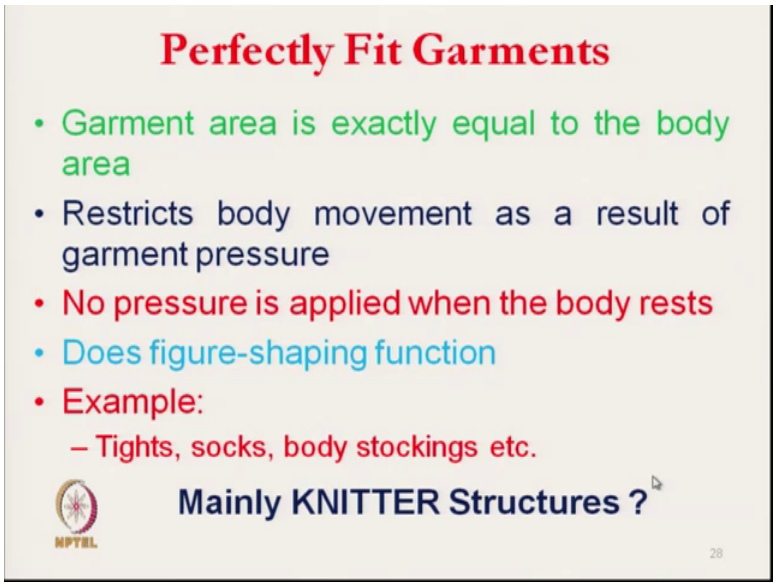


Next is the Perfect Fit Garment. The garment area is exactly equal to the body area. So, we have developed the perfectly width. What to do with that perfect fit garment, because it restricts body movement as a result of garment pressure. So, this garment fit garment is normally is of no use if we do not care about, if we do not take care about the extensibility of the fabric. So, it will not apply any pressure on our body if we are resting, if we are not moving unlike the Foundation Garment. Foundation garment is supposed to apply pressure when we are at rest, but in this case if we start moving, then the garment will restrict our body movement. It will apply the pressure on our body and it does figure shaping foundation, function.

So, it will actually sometime it is required for figure shaping. The example is that tights, socks, body stockings, other examples and these are made of mainly knitted structure because the restriction of body movement has to be reduced and this is reduced by the knitted structure which is inherently extensible nature. If we have to use oven fabric, when we have to use of fabric of extensible in nature, extensibility should be high like a

fabric should be made of some extensible fiber and loose fit garment where garment area is more than the body area.

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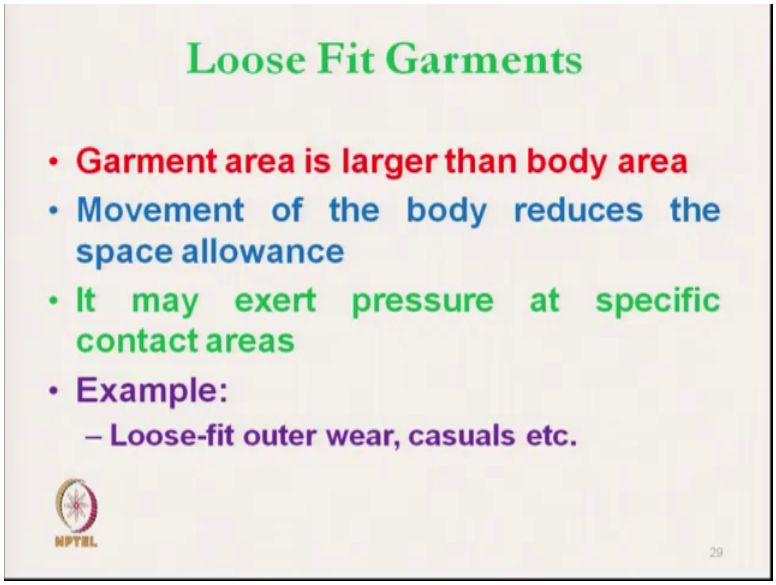


The movement of body reduces the space allowance. So, it does not restrict the body movement, but as the body movement increases, it reduces the space allowance and it continuously changes the microclimate thickness, continuously changes with the body movement and sometime it may exert pressure towards specific areas, specific contact area. It is not the overall pressure sensation, loose fit outerwear casuals sometime with the exert pressure in some places.

So, there are what we what we have observed that there are 3 types of Fitness Garment Fit. So, depending on our requirement, depending on the on our comfort requirement, depending on the thermal comfort or tactile comfort requirement, we have to select the type of fit and also depending on our the type of fabric.

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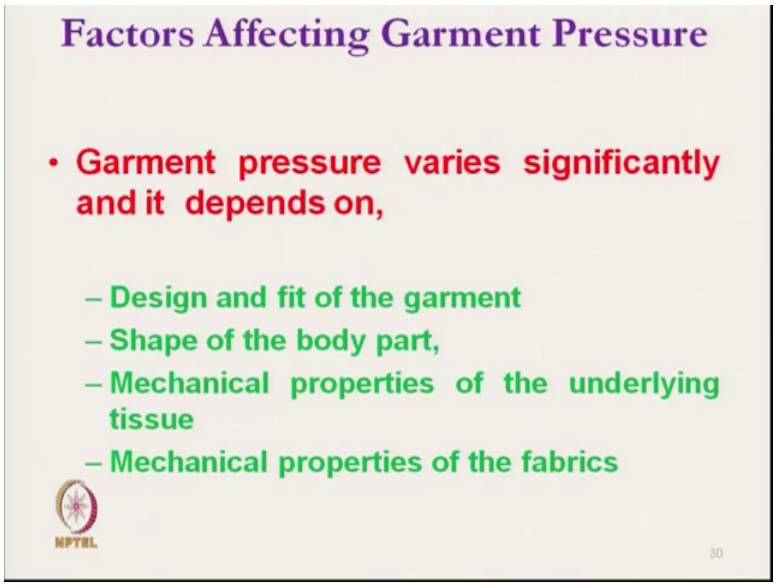


So, the factors which affect the garment pressure are design and fit of the garment. So, garment pressure varies significantly and it depends on the design and fit of the garment of proper fit garment with wrong design creates higher pressure for a particular pressure. Shape of the body part that is obvious and mechanical properties of underlying tissue and mechanical properties of fabrics; so, a fabric with rigid structure like elasticity is less or tensile rigidity is high, that fabric will give us higher pressure, fabric with higher bending rigidity will exert higher pressure, a fabric with higher shear rigidity will give us higher pressure. So, this mechanical properties of fabric is also important and fit of the garment as we have discussed.

So, if we have the fabric with highly rigid structure and higher a bending rigidity, we should it is go for the loose fit garment. So, all these parameters we have to take into consideration to have proper garment pressure.

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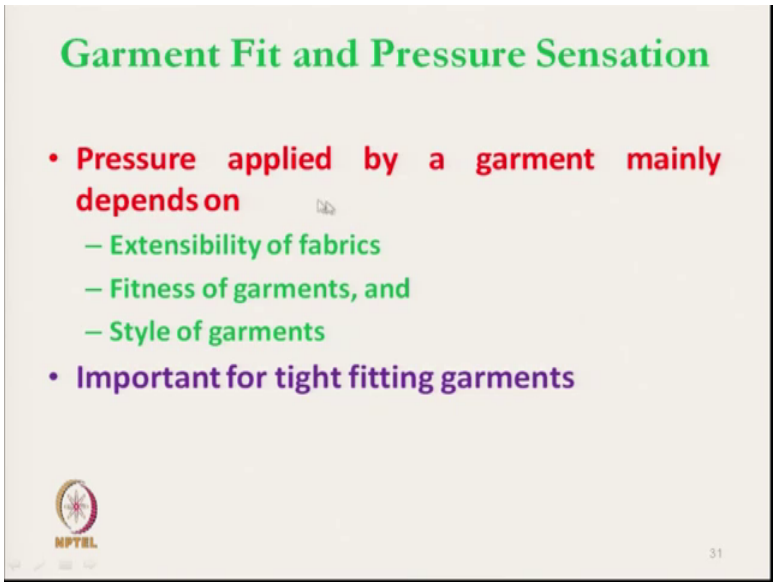


And pressure applied by the garment mainly depends on the extensibility of the fabric as we have discussed. Higher extensibility will exert less pressure on the body, fitness of the garment and style of the garment that you have just discussed and important for tight fitting garment. So, this for tight fitting garment, all these parameters are important. So, we have to select fabric properly.

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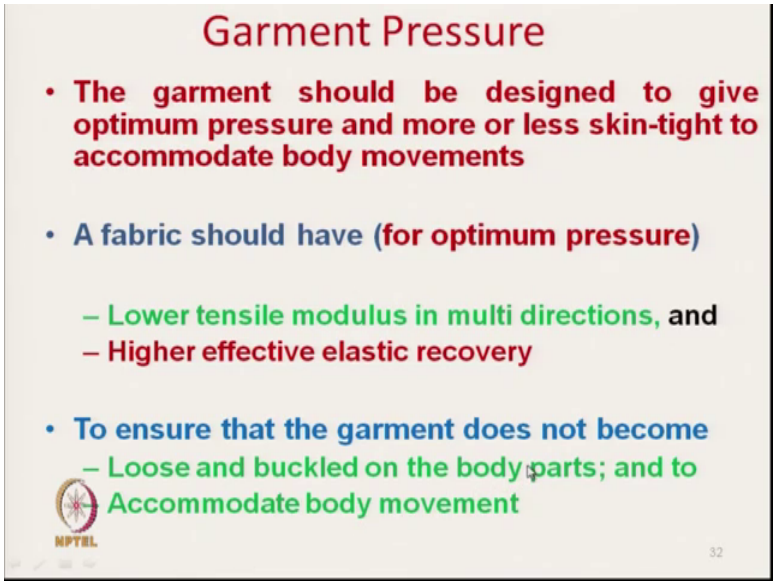

So, in the Garment Pressure, the garment should be designed to give optimum pressure and more or less skin tight to accommodate body movement. A fabric should have optimum, for optimum pressure should have lower tensile modulus in multi-direction.

So, if you want to impart optimum pressure, we should select the fabric with lower tensile modulus higher effective elastic recovery. That means, it should be it should recover properly and to ensure that the garment does not become loose and buckled on body parts because if the extensible elastic recovery is not proper, after stretching the fabric maybe loose or it is may be buckled, and accommodate the body movement.

So, if we can develop if we can take care of these parameters of fabric, these characteristics of the fabric, we can actually control the garment pressure related sensation and comfort related to the garment pressure. So, we will continue with this Garment Fit and Pressure related discussion and we will discuss few studies in the next segment, till then.

Thank you.