Science of Clothing Comfort
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Lecture -19
Tactile Aspects of Clothing Comfort (contd…)

So, hello everyone; so, in last class we have discussed the different modules of a Kawata evolution System for Fabrics, KSF. So, module 1 which actually measures the tensile and shear related characteristics; module 2 it is a bending related characteristics; module 3 it is a compressional related characteristics and module 4 surface friction and roughness related characteristics.

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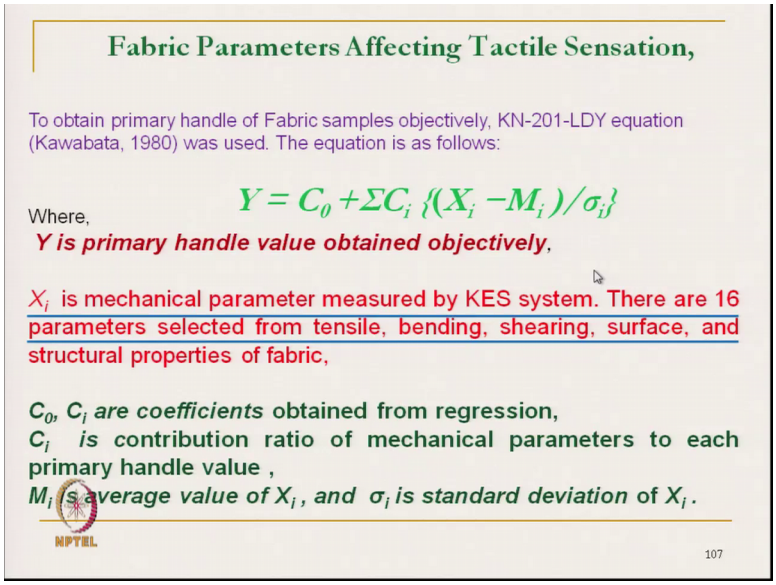

And also we have mentioned that ultimately we get large number of different types of parameters around 16 parameters we get. And now what do we with this parameter?

So, actually Kawabata system it provides one mechanism to get ultimately overall fabric handle value using all this parameters. Now, this is the equation which we have mentioned that Y is a parameter which we try to get the handle related aspects or tactile which affects the tactile sensations and C 0 is a coefficient of the equation and C 1 is the C i is the contribution ratio of particular parameter which is used.

So, X i denotes the different parameters like tensile related parameters, shear related parameters. So, these are the individual parameter and M is the mean of this parameter X i and this is the deviation standard deviation of X i. So, using this and all the parameters may not be significant for a particular handle response, the tactile response. So, these parameters are they are equations and their weightage is a different, contribution ratio is different for a particular. Now let us see an example of a; it is a mechanical parameter.

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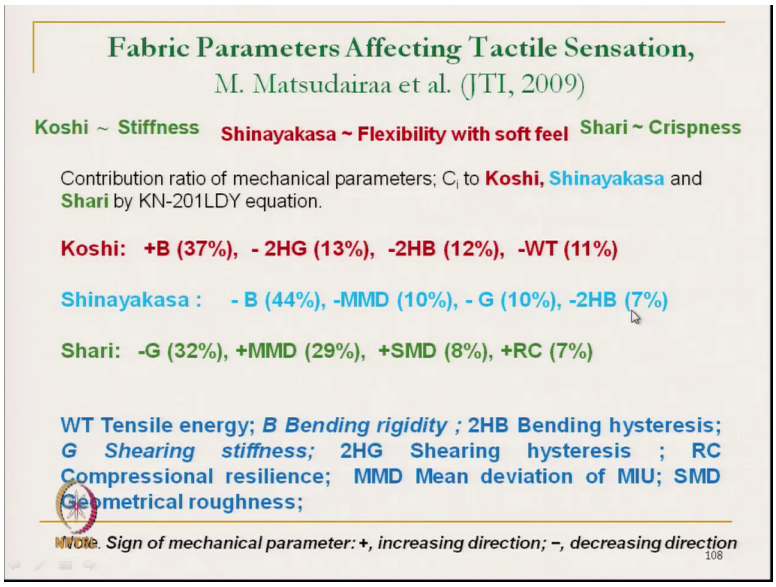

Now, we let us see example of three parameters ok; the Koshi, Shinayakasa and Shari ok. Koshi as we have seen earlier, it reflects the stiffness related characteristics, Shinayakasa is flexibility with softness related characteristics and Shari is crispness.

So, contribution ratio of mechanical parameters C to Koshi, Shinayakasa and Shari using this earlier equation which is we have that can you can always immediately get; like Koshi, what is Koshi? Koshi means it is a stiffness characteristics. So, here it has been observed that four parameters are important parameters which are significantly affect, ok.

Now, here we can see the parameters with the positive sign and negative sign. Positive sign means it is actually its increasing direction. If it increases this will increase that here if you see for measuring Koshi, which is it is not the exactly stiffness in last class we have discussed it is not exactly stiffness its related to the stiffness and Koshi its contribution is 37 percents maximum contribution, that to its in positive direction; that

means, what is Koshi B? B is the bending rigidity, bending rigidity which is measured in the KSF tool system. KSF tool system measures the bending rigidity and it is directly related with the Koshi value; that means, if you get higher bending rigidity, so, will get higher Koshi value.

And if you see it is a 2HG; what is 2HG? It is a shearing hysteresis; shearing hysteresis it is a negatively correlated. What is this? This means higher shearing hysteresis gives lower Koshi value; that means, it is not the stiffness, it does not talk about the stiffness. It talks about the stiffer fab, higher bending rigidity with the lower stiffness, that is the type of thing its telling.

So, 2HB is a it is a bending hysteresis. So, bending rigidity is there positive way, but bending rigidity bending hysteresis should be in the negative side, 12 percent contribution, but that means, higher bending hysteresis will give us lower Koshi value and WT it is a tensile energy. So, tensile energy also higher tensile energy will give us lower Koshi value. So, this way this concept of Koshi its not that straight forward its an overall concept.

So, it is related with other parameters also. There are say these are the parameters, it is a WT, it is a tensile energy, it is a then bending energy, bending hysteresis, it is a shear stiffness, shear hysteresis, compressional resilience, mean deviation of MIU, MMD and SMD, geometrical roughness. So, all these parameters are related here with this. Let us see the Sinayakasa. What is this? It is flexibility with soft feeling, flexibility with soft feeling, if you see it is a maximum contribution is bending rigidity.

Maximum contribution of bending rigidity here, but it is a opposite. So, here it is talking about the flexibility, Koshi was talking about the stiffness. So, minus B minus 44 percent means if we increase the B value will get lower Shinayakasa. So, it requires that means, soft lower B value will give us the higher Shinayakasa, although the contribution is very high. So, it is directly correlated, it is a inversely correlated with this ok.

And Shinayakasa it is a soft feeling; flexibility with soft feeling you what does it mean? It is see its MMD, it is a Mean Deviation of MIU, its higher mean deviation of MIU, it will give us lower value of Shinayakasha. Its contribution is 10 percent, G shear stiffness. Shear stiffness it is a higher stiffness will give us lower Shinayakasa. 2HB it is

a basically it is a bending hysteresis. So, higher bending hysteresis will give us lower value.

So, we can see this Shinayakasa from this contribution value, we can get idea about what does it mean. It is a total advance one feeling one type of feeling and Shari it is called as crispness. Its crispness of the fabric where G is the shear stiffness, it is related with that contribution is 32 percent. One-third contribution is of G value shear stiffness, but higher shear stiffness will give us lower Shari value lower crispness. So, if you want to have crisp higher Shari it will we need to have lower G value.

So, it is a another contributions is positive in nature its MMD, mean deviation of MIU; that means, the deviation of MIU at different point, it gives the crispness; that means, somewhere it is a slipping some time. So, we can see that this type of feeling in silk crispness, so crispy feeling, so it slips stick slipping right there. So, mean deviation of MIU it is a good indication of the Shari and SMD its contribution is that 8 percent; what is SMD? It is a geometrical roughness.

So, geometrical roughness is also. So, if the geometrical roughness is high it will give us the crispness little bit. So, maximum contribution is the shear stiffness. So, lower shear stiffness will give us higher Shari value and that higher MMD will give us the higher Shari value; that means, if you see if you take if we say eliminate SMD and RC compressional resilience their contribution. If you take talk about only this two contribution major contribution, we can see that it is a fabric should be should shear easily. It should shear easily, but the difference in MIU should be high, the MMD should be high ok.

So, higher MMD with lower G value. So, this way we can get the concept of that this contribution and their tactile sensation ok. Now, we will start another set of instruments which is FAST instrument and this fast instruments developed by CSIRO Australia.

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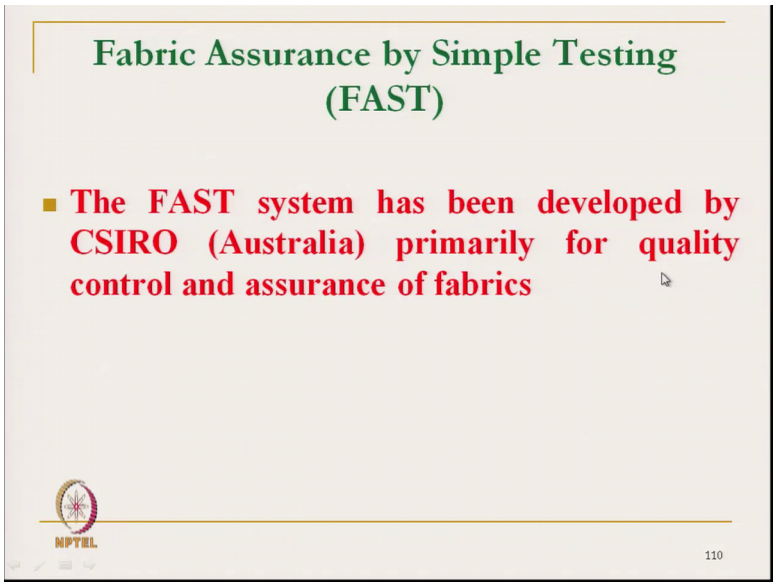

So, this is and it is a primarily it is actually it is a quality control and quality assurance purpose, but indirectly we can use this for measuring the fabric tactile responses.

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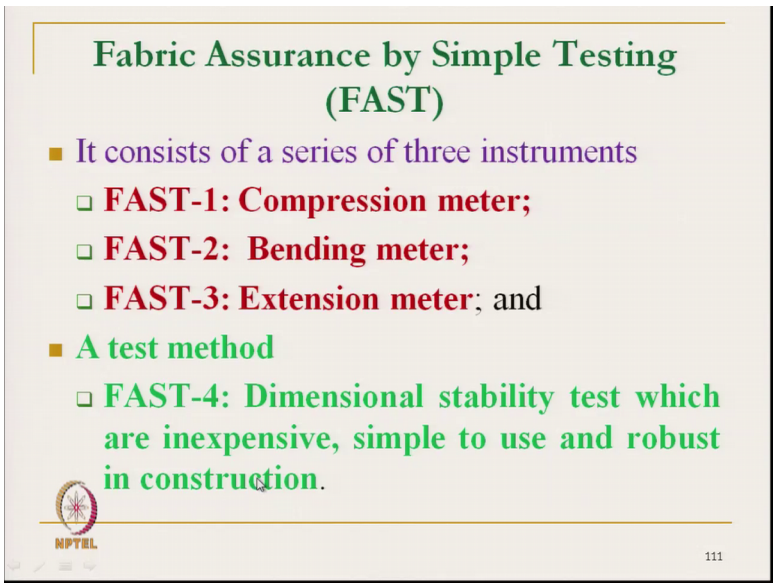

So, object it gives the indication of the fabric handle. The instruments are very simple, but the analysis of this from this data it is very nice ok.

So, we will see that with very simple measurement, we can get wide range of data, wide range of information. So, this total fast system, it consists of three text parameters, test instrument; three instruments are got. One is compression meter, it is a simple

compression tester and it is not like Kawata, Kawata system. KSF system gives the total curve, it measures it is a very complex, it is very complex system it gives the total loading direction and unloading direction, it takes the total data, but here in fast system, it does not give any continuous measurement.

In Kawata both loading and unloading direction we get continues data continues curve. Fast system we do not get any continues curve, it is a discrete data; very discrete data, its 1 or 2 data it gives. From there only beauty of this system is we get we can analyze, if we analyze properly we will get large number very nice information.

So, it has got fast has got three instruments. So, FAST-1 is a compression meter, FAST-2 gives it is a bending meter and FAST-3 its extension meter ok. So, here all in all this three we do not get any curve and this all this things, all these three instrument, it works in unidirectional, one direction in only in the loading direction. We do not get in the anything any information during the unloading direction ok. And fourth one is it is not an instrument it is a test method. What is the test method? FAST-4 is the dimensional stability ok.

Test which are inexpensive, it is a very it is a this FAST-4we can we do not need any instrument, we can actually develop one system of measurement and this instruments are it is not that complex these are robust in construction and but this all this three four modules can be interlinked in a with the computer, its output can be interlinked and ultimately we can get the information ok.

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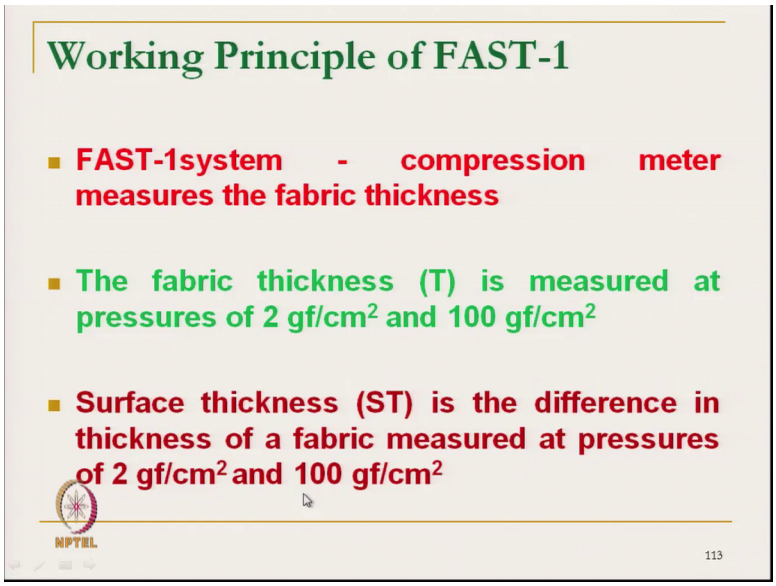

Now, let us see FAST-1 working principle of FAST-1, it is a compression meter, it measures simply it measures the fabric thickness and nothing else, but let us see how do we get large information ok, very nice information. The fabric thickness it is a thickness gauge; it is nothing but a thickness gauge. So, fabric thickness T is measured at a pressure of 2 gram force per square meter and 100 gram force per square meter. This that is all. At two different thickness pressure we measure the fabric thickness and from there we get the idea of surface hairiness which is the term it is a surface thickness. Surface thickness its a difference in fabric thickness at 2 gram force per centimeter square pressure and 100 gram force per centimeter square.

So, within this 2 gram with 2 pressure, if the fabric thickness changes, then the difference is known as the surface thickness. That means, this surface thickness gives the idea about the surface hairiness. Suppose a fabric does not have any hairi, a fabric made of say monofilament yarn or yarn fabric is synched there is no hairiness. So, the difference between 2 gram force per square centimeter it is and even a 100 gram force per square centimeter it is a very low pressure. So, this in this 2 difference will be very low.

But if the fabric surface contains large number of hairs, so, that hairs will first get compressed at lower pressure. So, that the difference will be high that actually is indicated by ST. So, only by measuring the thickness we get idea about the presence of

surface hairs. So, we can get idea of the prickle sensation also from this ST value, this is surface thickness.

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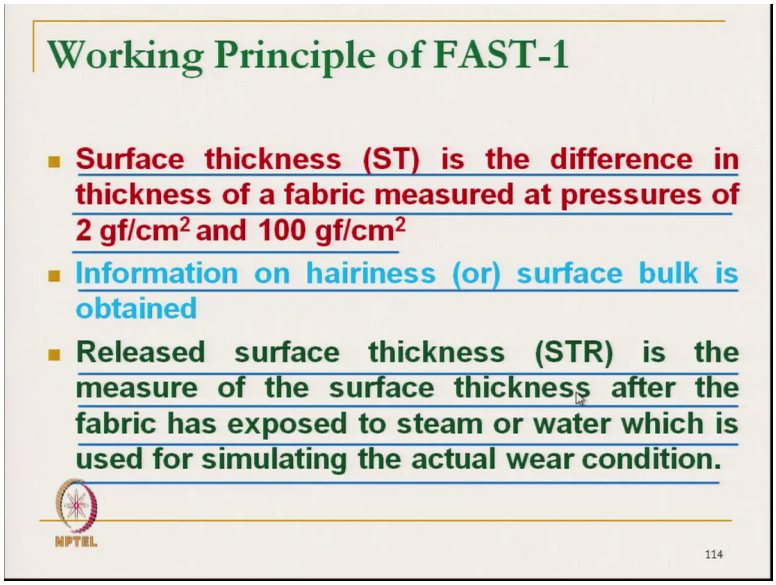

So, it is a difference in thickness measured at two different pressure. Information on hairiness or surface bulk is obtained. So, it is a surface bulk we can obtained a fabric may be soft at the surface and hard at the core, so, that way we can get idea about this by measuring the surface thickness.

Another term we can get it is called released surface thickness. Released surface thickness is its nothing but surface thickness after the fabric has exposed on steam or water, which is used to simulate the actual wear condition. Now, released surface thickness is the parameter which will give us an idea about the presence of or permanence of particular finish. Suppose we have given one calendering finish, calendering finish and after one use after certain time if we get, so, if we get the calendering finish, so that means, the surface here surface is stiff.

So, we get certain surface thickness, ST value before use. So, that value we get, but after say one laundering or after the one wash, so, this surface hair's has come up; that all this hairs have come up and the surface thickness value will change. So, that change that is after treatment after washing treatment if we measure the surface thickness, it will be surface release surface thickness. If there is wide difference between ST and STR that means, that whatever finished has been applied, it is not permanent, it has been washed

out. So, that STR and ST the difference value it gives an idea about the whether the finish applied is actually there, it is a permanent or it has been washed out.

So, this gives an idea and accordingly we will get the our tactile sensations. So, this is the surface thickness and released surface thickness as we have discussed.

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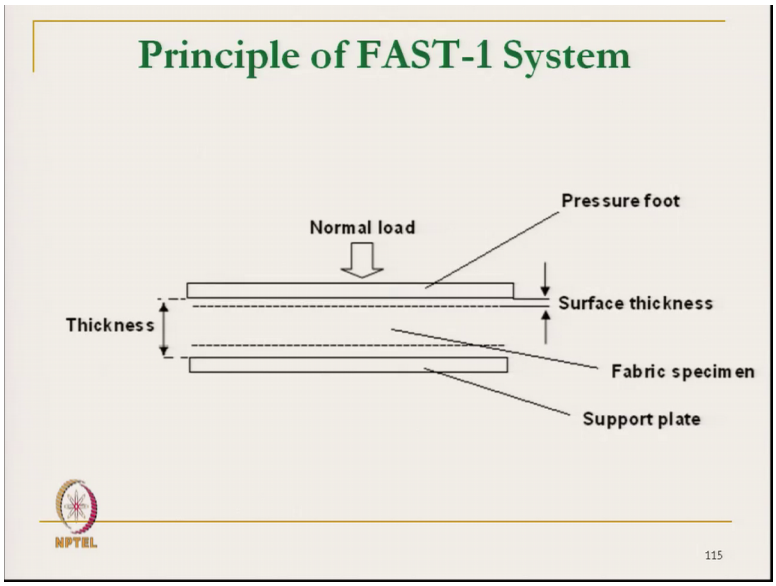

And try to see the principle, its very simple. This is the support here is the fabric this is the fabric sample and we know the fabric thickness and this is the pressure foot and this the thickness gauge will gives us an idea about the thickness and now at certain pressure as we have discussed, so, these are the pressure at 2 gram force per centimeter square and at 100 gram force per centimeter square, if we measure this thickness.

So, this is the thickness difference. So, this is the difference is surface roughness surface thickness ok. Now and if you wash it wash the fabric, we may get higher surface thickness this is that is called released surface thickness. So, from there from here we can get the idea about the thickness, idea about the hairs present at the surface and also idea about the whatever finishes we have applied, the finish is actually working or not, whether the finish has been washed away that information also we can get by released surface thickness.

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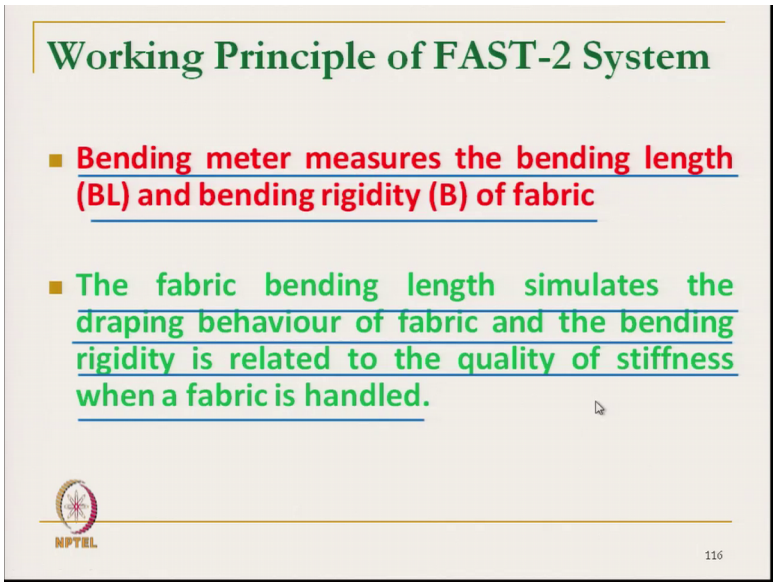

Now, the next module is a it is a FAST-2 which is bending meter. It is exactly similar as the Shirley bending tester and will we get the similar characteristics here, bending length and bending rigidity and the measuring principle is exactly same as the shirley bending tester and fabric bending length its simulates the draping behavior.

So, the bending length value, we get the idea about the draping behavior and bending rigidity. So, this we can get and which is actually indirectly give idea about the stiffness of the fabric. So, stiffness indirectly gives the idea about the tactile sensation. So, from BL value and the bending rigidity value we get indirectly the idea of the tactile sensation of the fabric.

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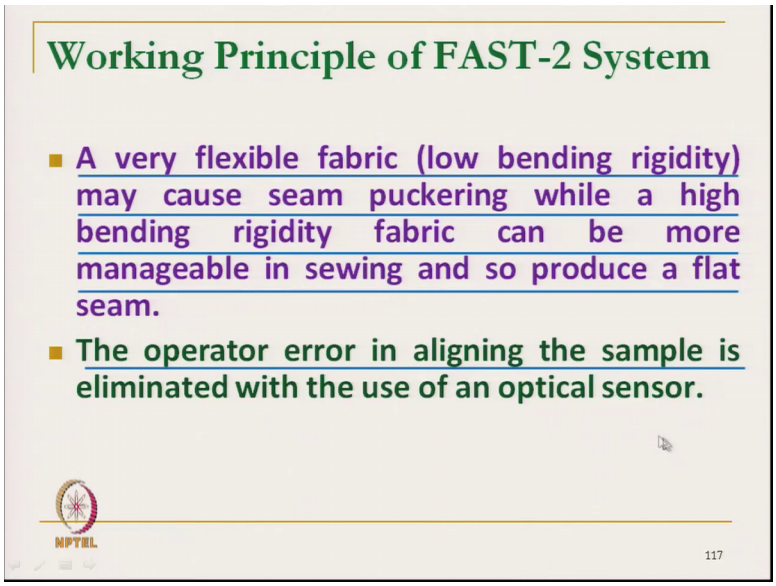

So, a very flexible fabric with low bending rigidity may cause seam puckering. So, it actually in addition to the tactile sensation this information this FAST instrument measures the it gives the idea about the sew ability of the fabric.

So, a fabric with a very low bending rigidity will may cause seam puckering. So, while fabric with a high bending rigidity, can be more manageable in sewing. So, produce flat seam. So, that we can get idea about the performance of the fabric during sewing operation and the operator error in aligning the sample is eliminated with use of an optical sensor. So, that operator error can be eliminated because in this instrument the alignment of the sample is very important and optical sensor is used for better alignment.

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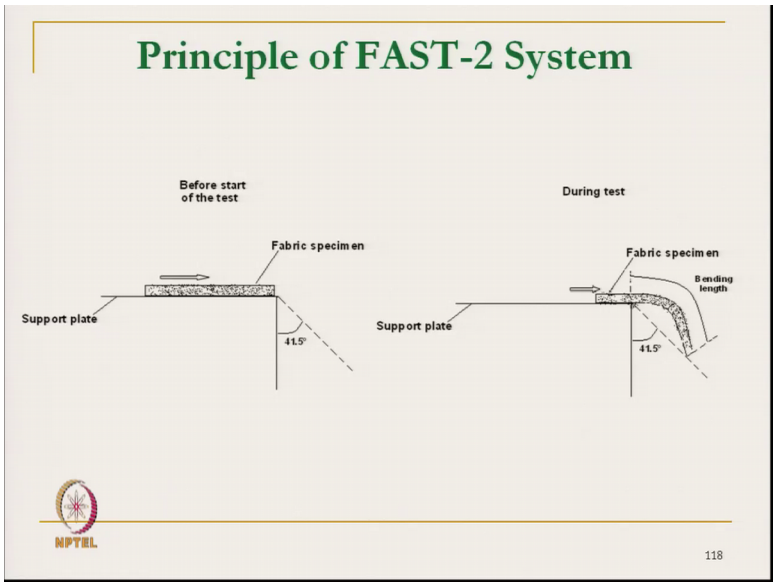

So, this is the FAST system, its exactly same as the shirley bending stiffness tester and here is the bending length and which 41.5 degree 5 degree angle, it as soon as it measure, this is free length is the it is a bending length.

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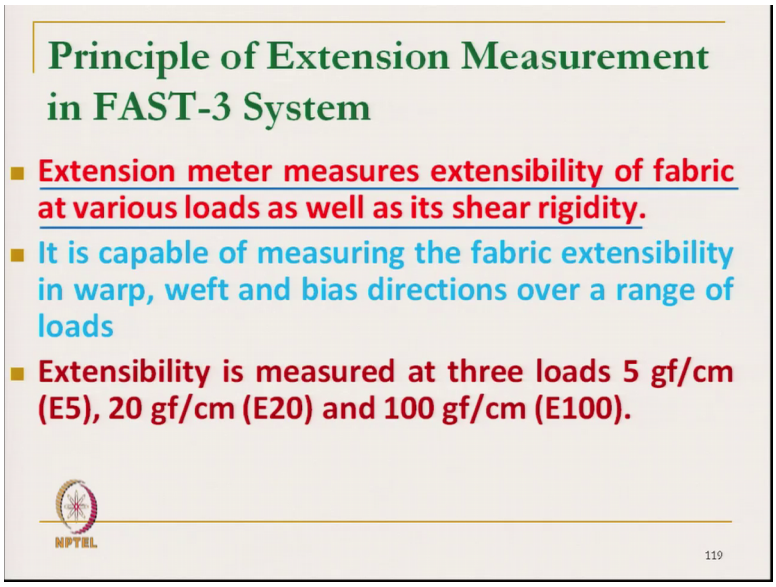

And FAST-3 is a it is a extension meter. So, this instrument gives idea about the tensile as well as shear rigidity. So, this it is gives idea about the extensibility, it is not the tensile because its only gives the extension extensibility of the (Refer Time: 25:13) because at the fixed load dried wet if we actually it is if it hangs, what is the extension? It gives the

only that idea it is not like Kawata system where we actually load and unload and as well as it gives the shear rigidity value. It works in two different module. So, arrangement of fabric will be different for extensibility measurement and shear rigidity measurement ok.

It is capable of measuring the fabric extensibility in both warp and weft direction and also bias direction. So, when it is working in bias direction that time it gives the shear rigidity. And when it is working in warp and weft direction it gives the extensibility of the fabric. So, extensibility is measured at three loads; one is 0.5 gram force per centimeter, it i s called E5 then 20 gram force per centimeter it is a E20 and 100 gram force per centimeter it is a E100.

So, the actual extensibility is we can get that from anywhere from 3 E, E 100 is the extensibility of the bending. But formability of the fabric we can get idea from E5 and E20. So, at lower level of extension at lower load extension at lower level of load which gives the idea about the formability we will discuss.

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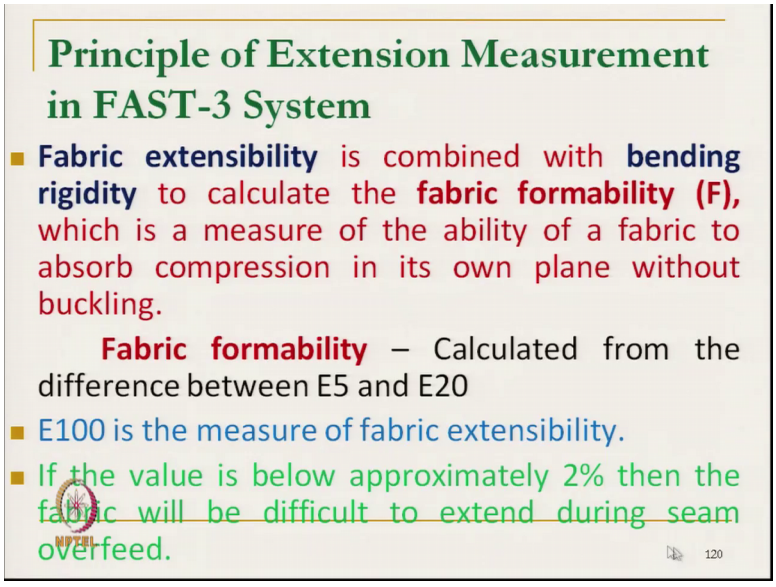

So, fabric extensibility when it is combined with bending rigidity to calculate the formability. So, which is measure of ability of a fabric to absorb compression on its own plane without buckling that is called formability.

So, that means, with a lower level of extension and bending if you know. So, fabric actually if anything any material if we compress if we buckling if we compress it will

start buckling, but fabric actually takes little bit time. It is depending on the bending rigidity and the extensibility it actually that some during sewing operation, during other various other operation it is has to absorb little bit compression; actually longitudinal will compression it is not lateral compression longitudinal compression before it starts buckling.

So, compress longitudinal compression on its own plane without buckling. Otherwise if its start buckling from the beginning, then it may create problem in the during sewing operation. So, formability is calculated from the difference between E5 and E20. So, this two parameters are used and E100 is a measure of extensibility but this three parameters we get from extension meter. So simply we have to hang a constant weft and we get and we have to note down the data extends. But the instrument automatically note down the data from software and it gets the data and it calculates the formability value from the in combination with the bending rigidity value. If the value is below approximately 2 percent; that means, with this E100 then fabric will be difficult to extend during seam overfeed. So, that extensibility we can get idea.

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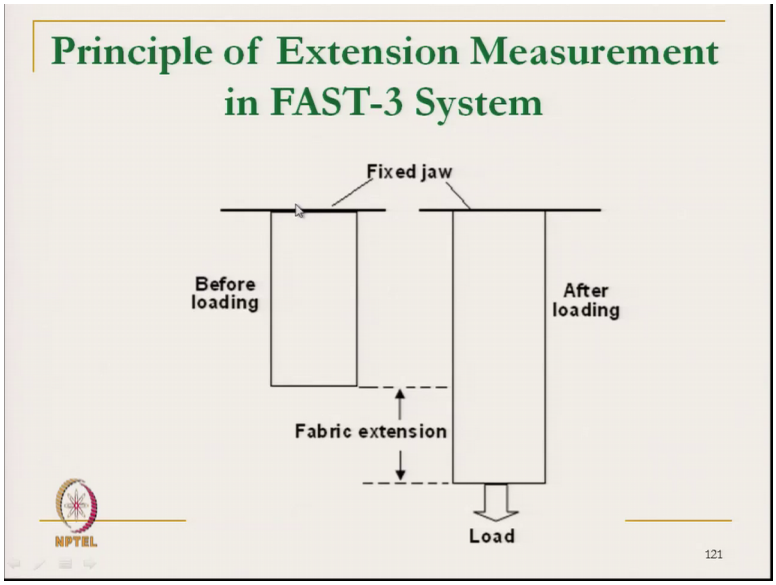

This is the simple measurement technique. So, before loading we know the distance length and after loading it may be a 5, may be 20, may be 100 we get the extension and automatically the software records the data and from there we can calculate. Next is the shear measurement by same instrument FAST-3. In the extension measurement we have

seen here the thread direction if you see the woven fabric, it is a warp, either warp or weft direction; this is either warp or weft direction.

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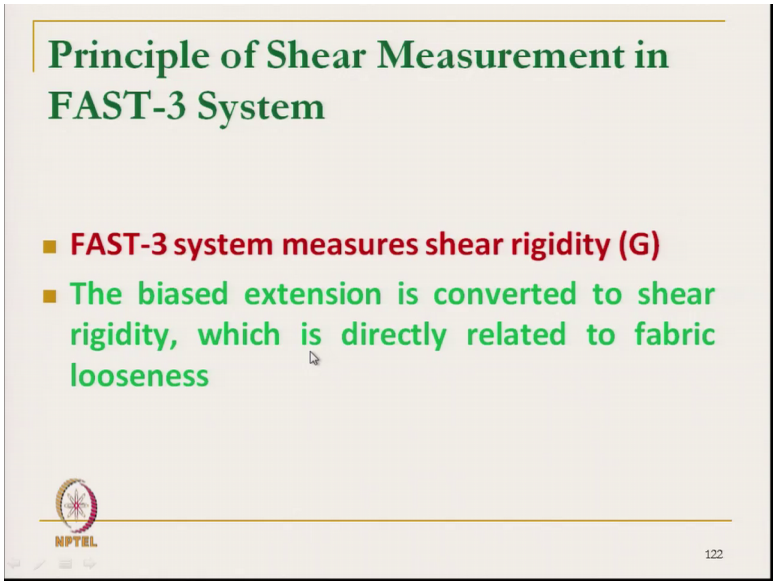

But in the shear measurement when you measure the shear rigidity, the it is not aligned in the either warp or weft direction its aligned in the bias direction. And the extension it is called bias extension and this bias extension at an certain load is converted in terms of shear rigidity.

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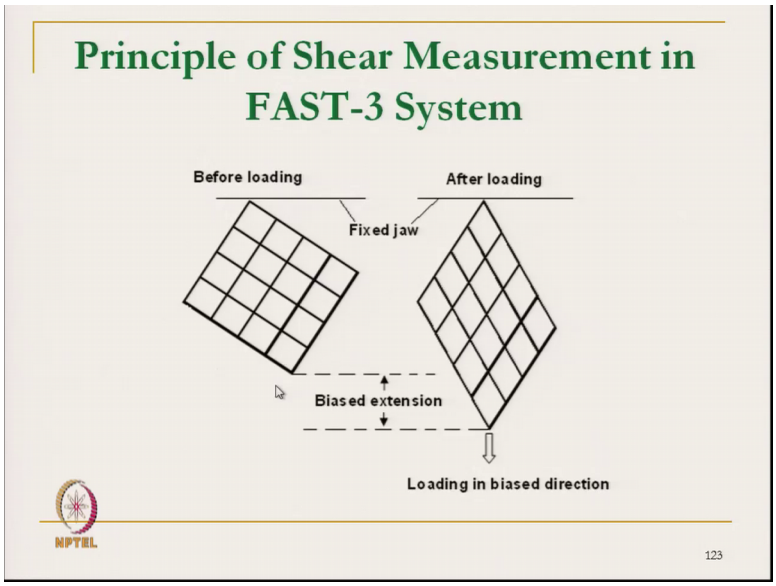

So, this is the type of arrangement. So, before loading this is the fabric arrangement and after loading and this is extension. So, lower shear force will give higher extension. So, from there simply by changing the fabric orientation, we can get the idea about the shearing. It is nothing, shearing is nothing but the movement of hair movement of yarned in it is inter less venture ok.

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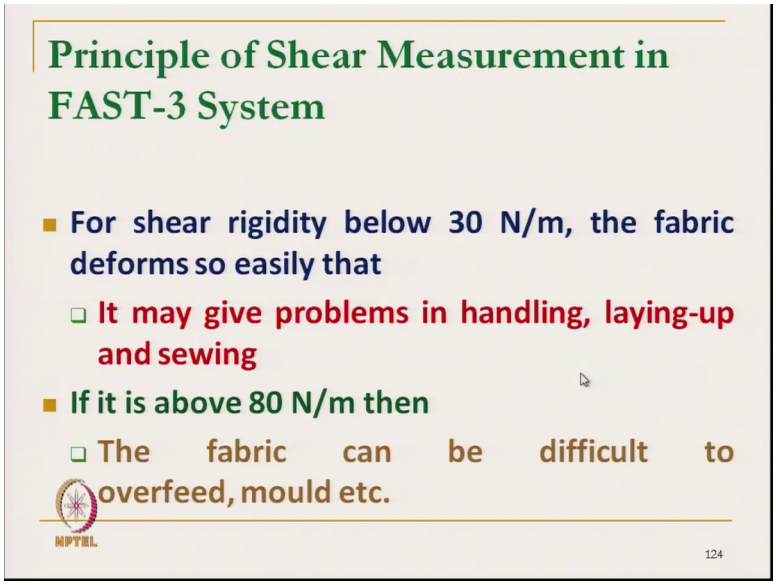

So, shear rigidity below 30 Newton per meter fabric deforms easily. So, that way and it gives a different types of problem, laying up and sewing problem and if it is above 80 Newton per meter it is a very stiff its difficult during sewing operation and there are different even it will idea about of the tactile sensation.

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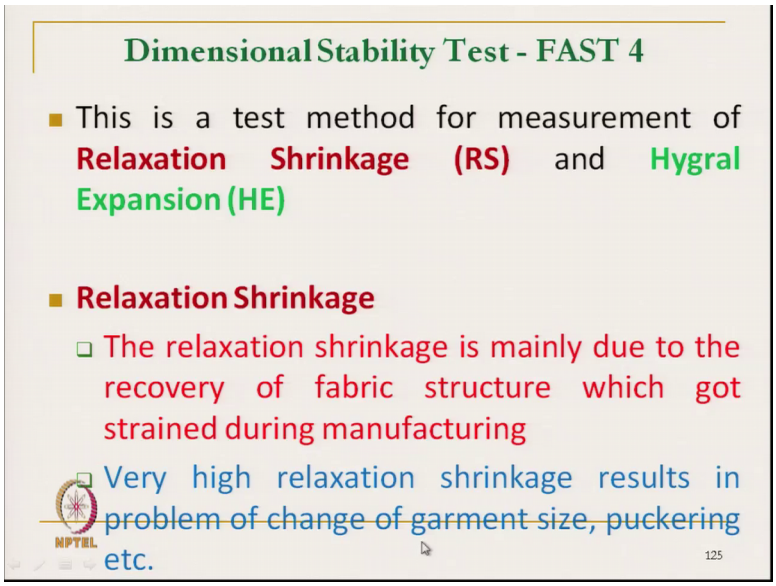

And the next one is a it is a system, which measures the Relaxation Shrinkage, RS and Hygral Expansion, its HE. What is Hygral expansion? It is a after when if fabric is in wet condition and after drying what is a change, change in length dimension; from there we can get the hygral expansion and relaxation shrinkage. Relaxation shrinkage means it is after washing and all this after relaxing if you dry, what is the actual dimension, what is the shrinkage.

So, relaxation shrinkage it is a mainly due to the recovery of fabric structure, which got strained during manufacturing. So, at the certain its get after manufacturing it is strained after that it is relaxed. And very high relaxation shrinkage results in problem of changing the size of the garment. So, it gives the different types of tactile sensation if the fabric it is highly relaxed then it will give pressure sense higher pressure sensation.

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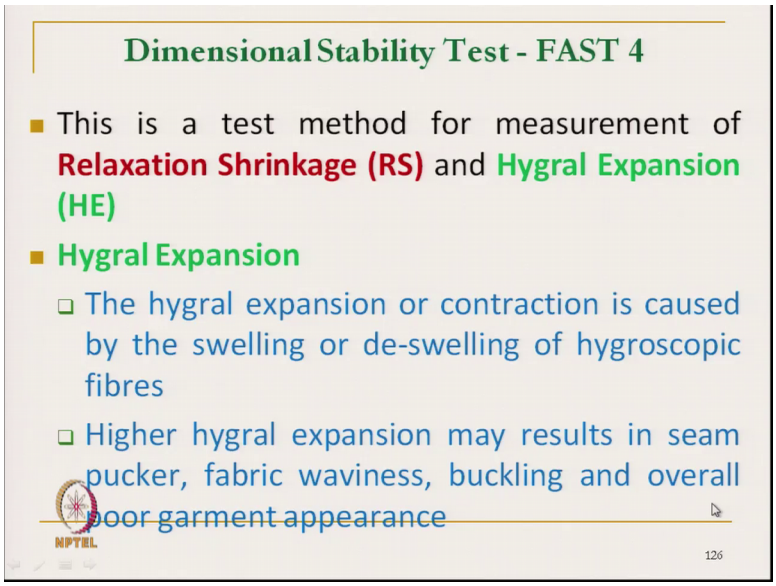

So, this is a test method for measuring the relaxation shrinkage and hygral expansion and hygral expansion or contraction. So, it may be two types. So, it depending on the fabric is caused by swelling or de-swelling of hygroscopic fibers. So, basically the shrinkage is it takes place when we during washing, its due to the swelling characteristics as we know. So, hygral expansion, higher hygral expansion may result in seam puckering, fabric waviness, buckling and overall poor garment appearance that will.

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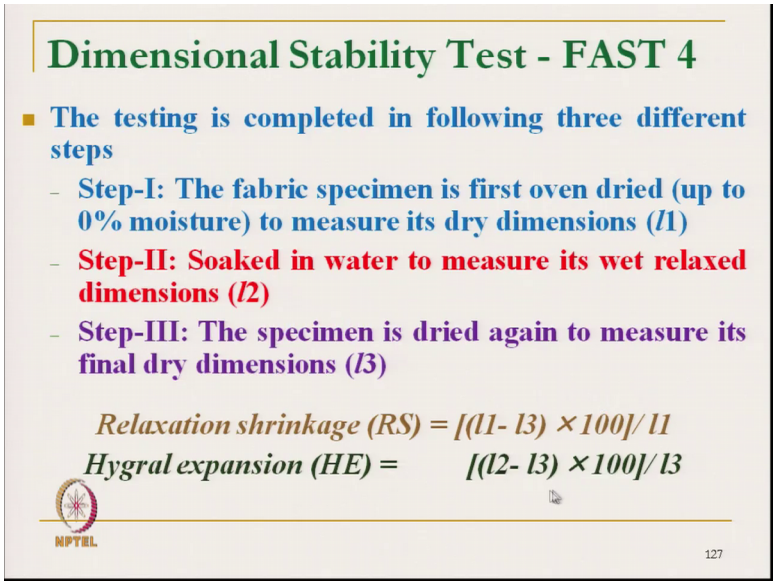

So, the testing is completed in following three steps ok. So, we have to have three steps; in step I, fabric specimen is oven dried. First we have to oven dry the specimen up to 0 percent moisture regain to measure the dry dimension. So, dry dimension is l 1 is the dry dimension then it is soaked in water and the wet relaxed dimension is l 2 and the fabric this then dried to measure it is the final dry dimension is the s 3, l 3.

So, l 1, l 2, l 3 are the three dimensions and from there, we can get the relaxation shrinkage is l 1 minus l 3 by l 1 whatever, this is the relaxation shrinkage and hygral expansion is l 2 minus l 3 by l 3; this is the hygral expansion. We can get the idea about it.

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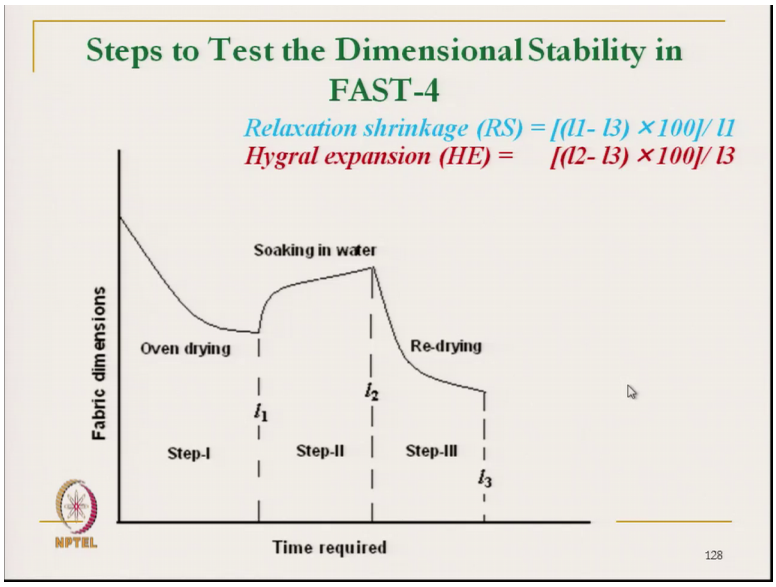

Now, try to see the total the steps; in step I, this is the fabric where actually first oven drying the fabric. First we are oven drying the fabric and getting the dimension l 1 length or breadth whatever dimension you want warp wise and weft wise, this is l 1, then we are soaking the fabric this is the fabric we are soaking. So, ultimately we are getting the length l 2 and after that we re-drying again, this is l 3.

So, this difference this is due to the hygral expansion this is due to this increasing this length the higher length as compare to l 3, l 2 is as compare to l 3 is due to presence of water because already the fabric has been relaxed here. So, that this difference is its with the reference to l 3 is known as the hygral expansion and relaxation shrinkage is from this to this once we are soaking and drying this total this gives the idea about the

laundering effect. So, when we laundry, we launder the fabric and a wash the fabric. We first soak with water and then dry. So, this gives RS gives the relaxation shrinkage. So, depending on this value we can get idea about the performance of the fabric.

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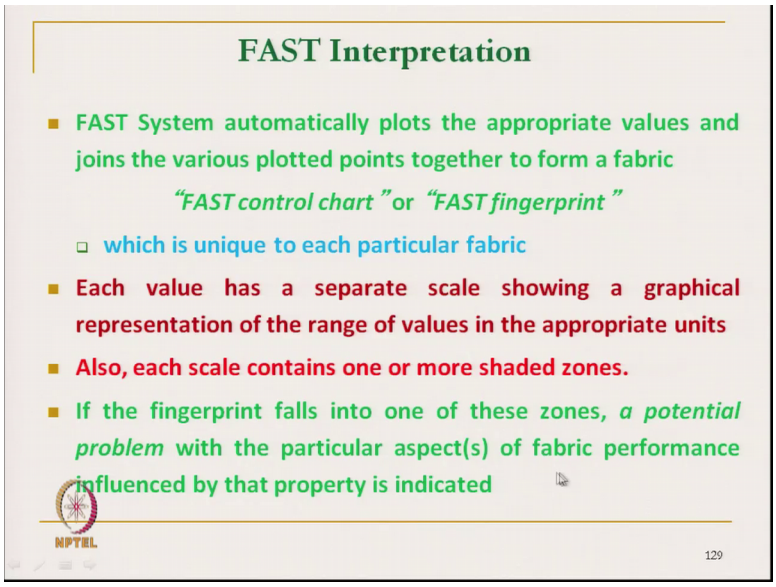

So, how to interrupt this data, which is very important in FAST level. Fast system, it is a very sample, but interpretation is very less. So, here the all the modules are connected with the computer and computer automatically gets data from all the modules and even including the first four module, we have to fit the data of the relaxation shrinkage, hygral expansion and finally, with this data it plots a curve which is known as the FAST control chart or FAST fingerprint and this is the chart for a particular fabric for a fabric it gives separate chart and from this chart, one can immediately get the idea about the fabric what will be its performance during application.

So, which is unique to each particular fabric for a particular fabric it is unique, each value has a separate scale showing in the graph I will show you the graph and separate scale separate parameter, they have got separate scale representing the range of value in appropriate units. It gives from say warp and weft direction. So, it gives the range of the values and the total value minimum and maximum value it will give and also the FAST chart is a it is a fixed chart ok.

So, it gives the range from minimum to maximum value and also it is a shaded zone is there. Shaded zone means it is a problematic zone within that zone if the fabric gives the

value that means we can anticipate some problem in application. If the fingerprint falls in to one of these zones that is the shaded zone, a potential problem with the particular aspect of fabric performance which is indicated.

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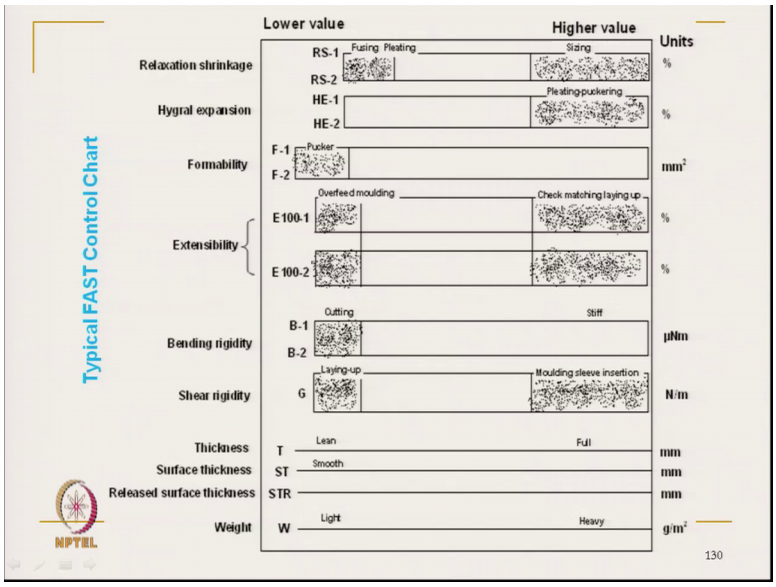

Now, let us see typical FAST control chart. This is the empty FAST control chart. Now, here we can see these are the graphs these are the this is the blank, chart it is a lower value, it is a higher value let us say relaxation shrinkage. RS 1 and RS 2, what does it mean? RS 1 means it is a warp direction, RS 2 say it is a weft direction. Hygral expansion it is HE 1 HE 2. See RS 1 relaxation shrinkage, if it is very low what will happen, the problem may be fusing or pleating problem. So, that problem it may create.

If it is high that is sizing problem its size if it is relax shrinkage is high; that means, size may get change. So, that type of problem will be there. Hygral expansion if it is low there would not be any problem it is good. If it is high there will be pleating or seam puckering. So, that type of. So, if our data falls in this zone, so that means, we can anticipates some potential problem of this fabric. So, we have to take action ok.

Formability, if it is high its perfect formability, but if it is low then formability problem will be there. Extensibility, so, formability F 1 and F 2, warp direction weft direction; extensionality E 100-1; it is a if it is low then there will be over fitting overfeed molding problem and if it is very high say if it is extends problem, then there is a problem of check matching layup means during automatic cutting in garment industry, the check

matching will be problem because it large number of layers are layed automatically and if the fabric is extensible; that means, the check matching if it is checked fabric then there will be a problem ok.

Then bending rigidity; so, if it high there will be cutting problem and shear rigidity laying a problem, thickness, surface thickness released surface thickness. So, this all this characteristics we, so, this thickness surface thickness released surface thickness this there is no warp and weft that is why it is a single line.

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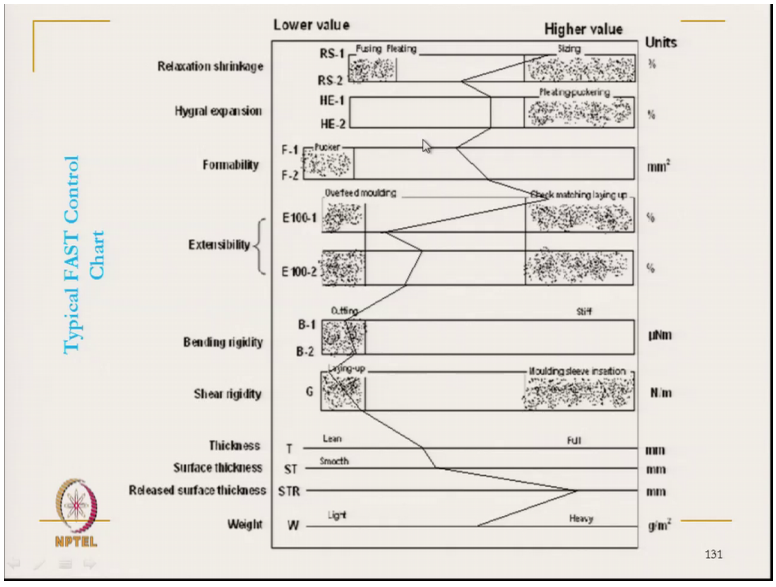

And this is the typical control chart. Now what does it show this fabric? Fabric is tested in FAST testing in FAST instrument and we get this control chart; that means, this fabric will have problem in sizing; sizing due to very high relaxation shrinkage of warp direction. The problem will be in the warp direction waft direction we do not have any problem.

So, we have to take action or whatever precaution we have to take we have to do ok. And say hygral expansion it is a perfect warp wise and weft wise hygral expansion is exactly same. Here warp wise and weft wise wide difference. Similarly, we can see this fabric will have problem with the say check matching problem at this in warp direction. So, it has got lower bending rigidity, it is this problem with this.

So, this will give idea potential problem which is going to have. So we can take precaution. So, this is one fabric which is which pass the FAST test. So, this fabric you can very well use for any application ok, but for other fabrics if there is any problem we can take either precaution or we can some corrective measure you can always take ok. And we will stop here. Next we will start other principle which is fabric extraction principle ok.

Thank you.