Testing of Functional & Technical Textiles
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Lecture - 2
Testing of Low Stress Mechanical Properties of Textile Fabrics (contd…)

Hello everyone, so, we will continue with the discussion of low Stress Mechanical characteristics. In last class we have discussed the first module of Kawabata evaluation system, which is KESF 1 where we have discussed that the low stress tensile force, tensile characteristics, and low stress shear characteristics those can be measured by KESF 1 system.

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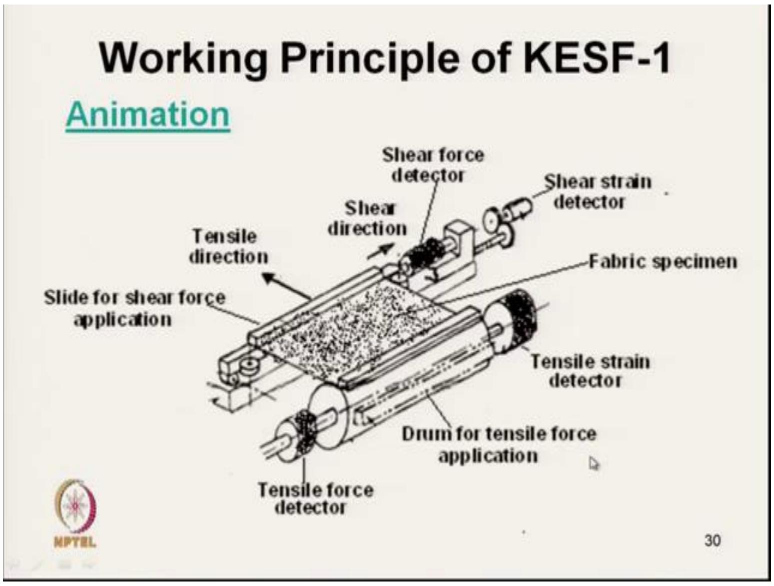

And, here the specific specimen is a stretched by rotation of the drum for tensile measurement and by sliding the other jaw, we can measure the shear characteristics, this details we have seen.

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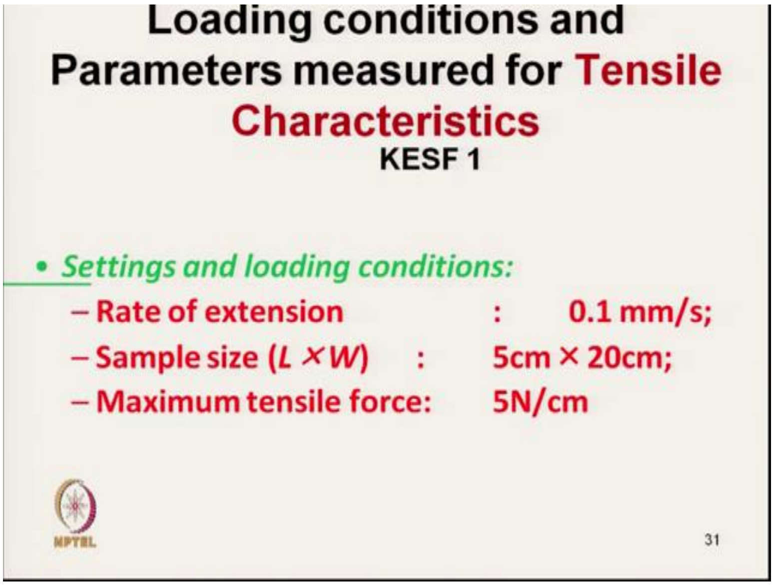

And, various loading conditions we have discussed.

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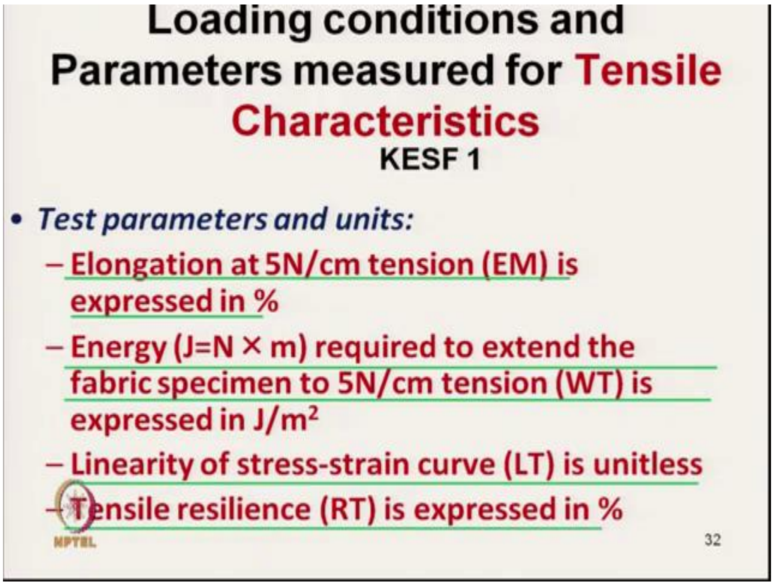

And, also we have discussed different test parameters which we get in different form.

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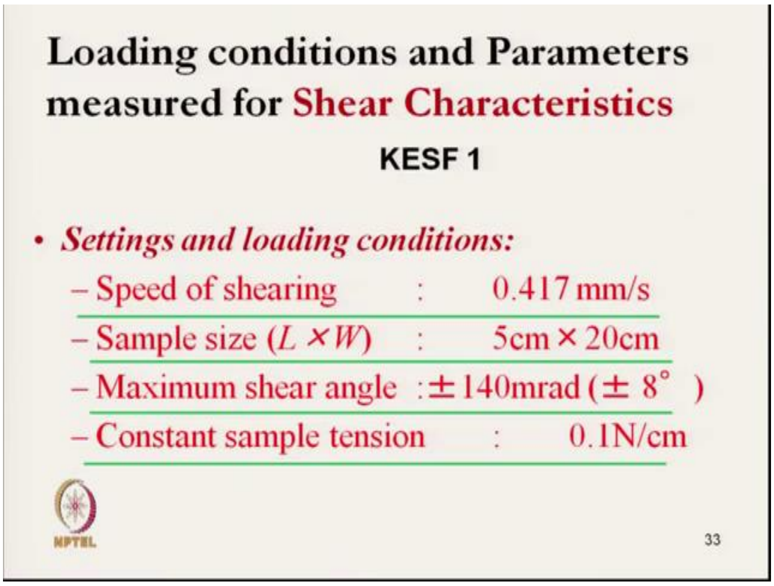

And, then we have seen the shear characteristics different test parameters for shear characteristics.

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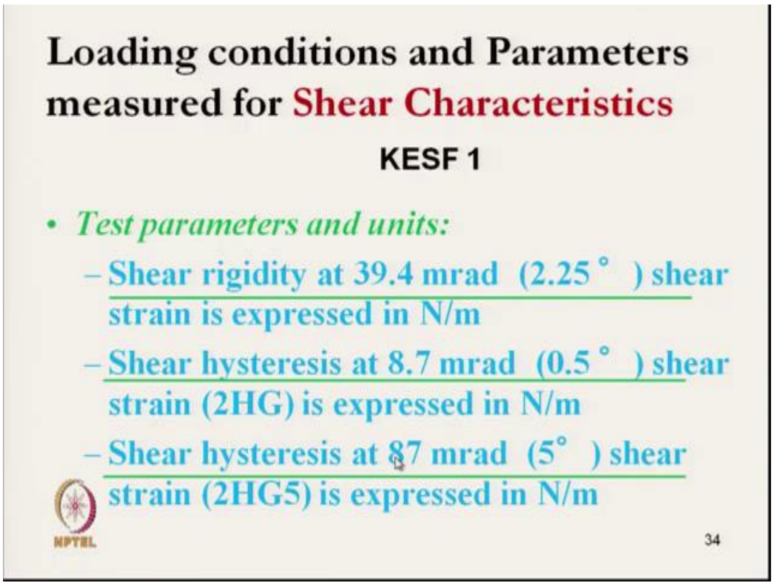

And, these are the different parameters we get.

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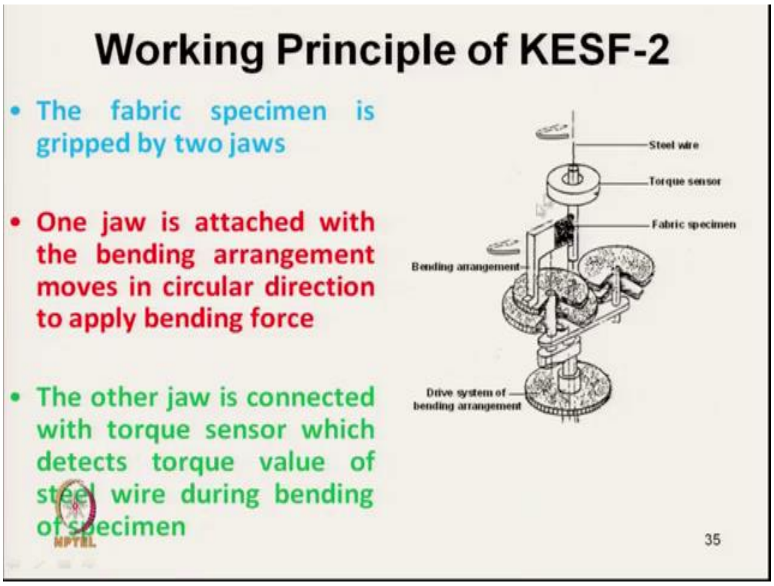

Now, we will start the next model which is KESF-2. The KESF-2, which measures the bending characteristics of fabric low stress bending characteristics, here it is not like the shirley bending stiffness tester or like loop method. In shirley bending stiffness tester what we have seen, we can only simply get the bending rigidity. Once the fabric is hanging on it is own mass, but that is not the exact situation or most of the handle related characteristics for functional textiles. For functional textile, suppose this cloth it is bending, not due to its own mass. We have to bend the fabric and the fabric stiffness is actually, it is due to the fabric stiffness, we get the some pressure on our body we get some handle characteristics.

So, the principle here it is very close to actual application. Suppose, this is the fabric sample, fabric specimen, here the fabric is gripped by 1 jaw ok. And, other jaw which is actually movable like this. In this process we try to get. And, here the bending curvature, it is fixed the fabric is bent to a specific curvature, and up to that curvature once it is bent then it again comes back. To the original point and then it is bent to the other direction in this way the bending is repeated. And, we get both the bending curvature and also the force required to bend a fabric this 2 data we can get.

So, the fabric specimen is gripped by 2 jaws here. So, this is the fabric specimen which is shown in black color. One jaw which is the steel wire this is the jaw here, it is connected with the torque sensor. And, another jaw it is a connected with the bending arrangement.

So, once this is moving this bending arrangement is moving the torque sensor will sense the required torque and from there we can calculate the bending force. So, one jaw is attached with the bending arrangement as I have mentioned and which moves in circular direction to apply the bending force.

So, this is the steel wire with the torque sensor and other side it rotates it is a circular direction it makes the arrangement is such that it rotates in circular direction to apply the bending force. And, the other jaw is connected with the torque sensor which detects the torque value of the steel wire during bending of specimen. So, this will detect the torque value and from the torque value we can get the bending force.

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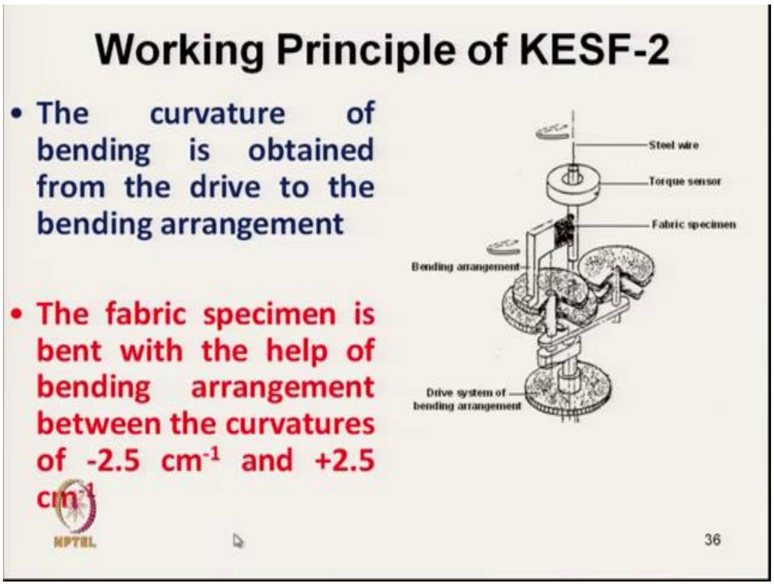

The curvature of bending is obtained from the drive to the bending arrangement. Here it is a drive arrangement. And, this drive arrangement will give idea, we can from the gearing arrangement of this drive, we can calculate the bending angle, total curvature we can calculate.

The fabric specimen is bent with the help of bending arrangement, between the curvature of ± 2.5 cm^{-1}. So, that is the curvature limit. So, +2.5 to -2.5 again it is it goes in that way.

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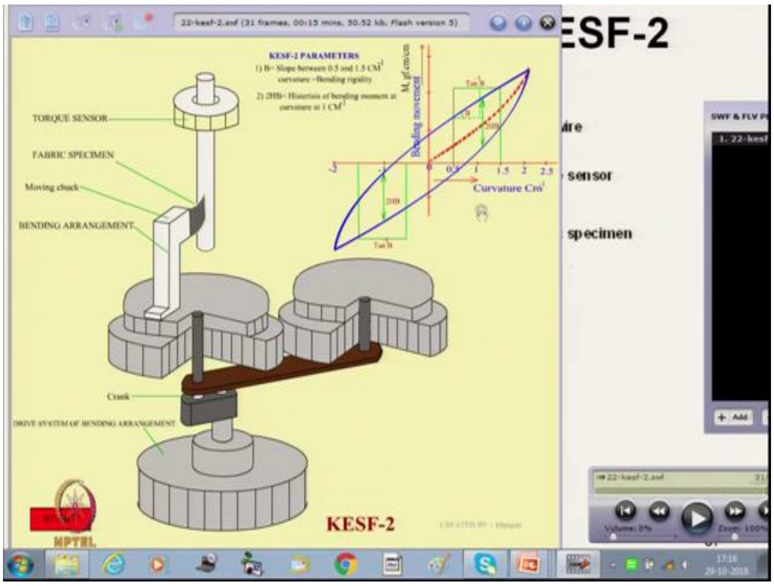

So, if you see the animation here this is rotated. And, it makes the system the bending system rotates in one direction and again it is come back in come back to other direction. And, this is the bending hysteresis curve. From here we can calculate the slope B, it is a bending rigidity B, which is the slope between 0.5 to 1.5, that is the curvature within that. So, this is 0.5 to 1.5 within that the slope if we take it is called the bending rigidity.

Another parameter which we get it is a 2HB, it is the hysteresis of bending at 1 curvature this is at curvature limit 1, and this is the hysteresis ok. So, from there we get 2 parameters one is the bending rigidity and other is the hysteresis which is 2HB.

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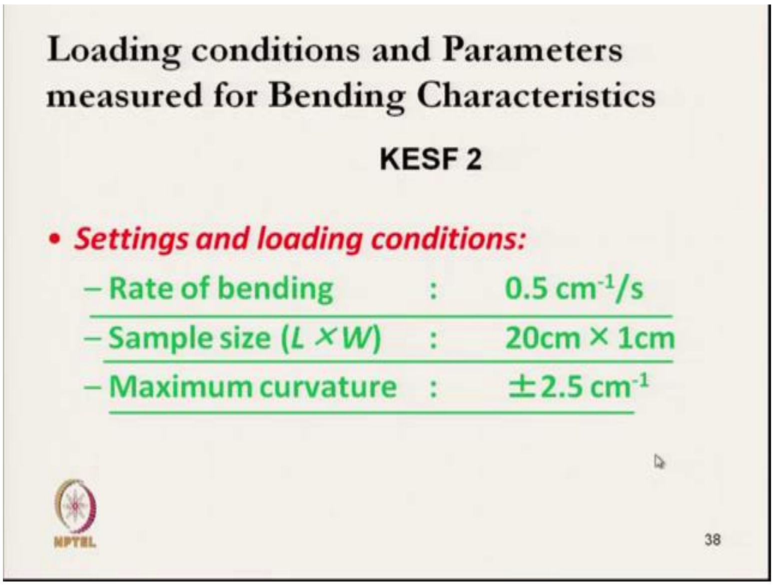

So, loading condition and parameters measured for bending characteristics are rate of bending which is 0.5 cm^{-1}/s, that is the rate of bending; that means, if we have to have say 2.5. So, it takes typically 0.5s in one direction another to come back again, it is a 0.5s takes it is in other direction.

±2.5 it goes. Sample size is 20 cm × 1 cm. So, length wise it is a 20 cm × 1 cm is the effectively it is a 1 cm is the width. So, that way it bends maximum curvature is ±2.5.

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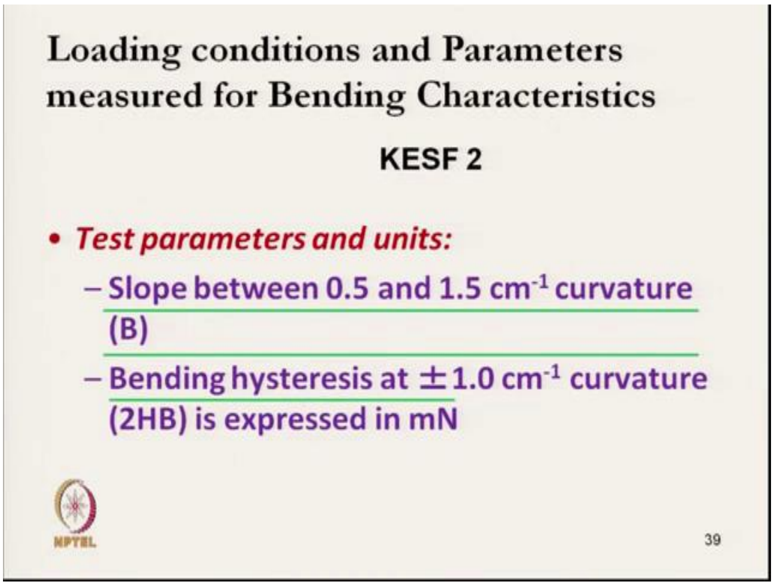

The test parameters as I have mentioned it is slope between 0.5 to 1.5, that curvature it is a B ok. It is a bending rigidity and bending hysteresis at ±1 curvature, it is a 2HB is expressed in mN. So, from here we get 2 parameters B and 2HB.

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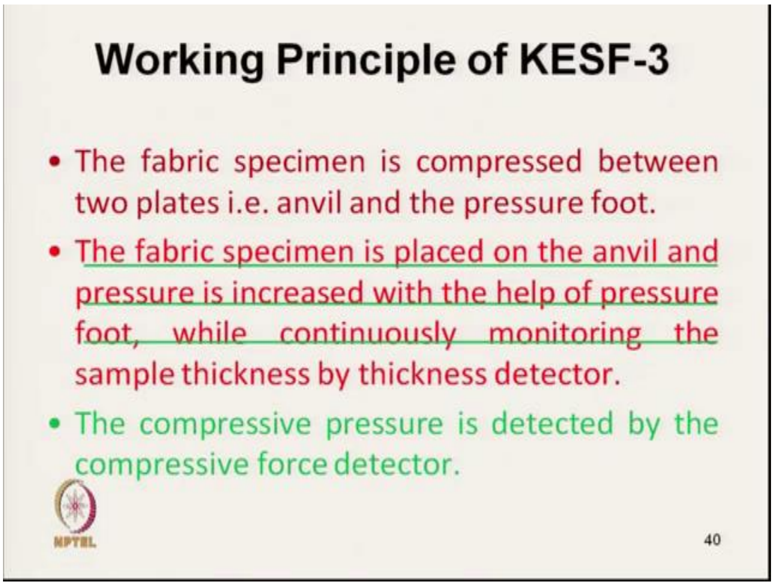

Now, the next principal is the, it is KESF 3, which is actually the compressional tester.

The fabric specimen is compressed between 2 plates; one is anvil which is support plate, another is the pressure foot. The fabric specimen is placed on the anvil and pressure foot is actually lowered. The so, pressure is increased with the help of pressure foot while continuously monitoring the sample thickness by thickness detector.

So, as I have mentioned here earlier also that the loading and the total thickness it is monitored, during the loading condition and the unloading condition. The compressive pressure is detected by compressive force detector. So, one is the compressive force detector, another is the which monitors the thickness by the movement of the cross head pressure foot.

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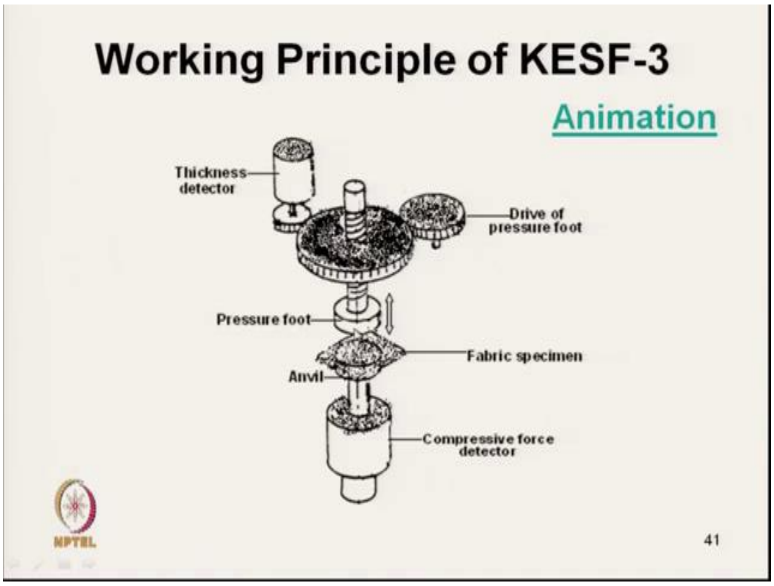

Now, this is the schematic diagram of the instrument, here this is the fabric specimen placed on the anvil; anvil is connected with the load sensor which detects the compressive force and the pressure foot which moves up and down, which is controlled by the drive system of the pressure foot. And, this rotation of this disk is measured by the thickness detector, which is the say another transducer which rotates which measures the angle of rotation from there it calculates the thickness ok.

Now, the system is that it moves down initially and as soon as the predetermined minimum pressure is reached, it will start that the drive will start rotating in other direction. So, pressure foot, will move gradually upward and the pressure will reduce. So, we will get the complete curve of loading and unloading. From this loading unloading curve, we can calculate different parameters. Let us see the animation for this system.

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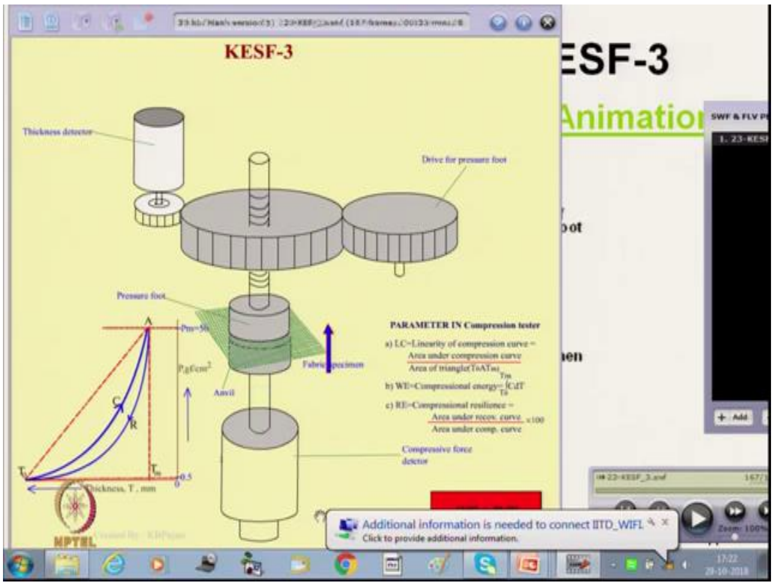

Now, the fabric is being placed between anvil and pressure foot. Now, the drive for the pressure foot is started it is initially moving downward and after reaching certain pressure, predetermined pressure it moves upward.

So, in this way we can get the complete loading unloading curve ok. So, after and this loading unloading curve this is the thickness, thickness is detected by this thickness detector and this load the pressure is detected by the this load cell. And, from this instrument after getting all this total entire curve for loading curve and unloading curve. So, we will we get the values ok.

So, here during loading so, initially this is the initial point during loading the thickness reduces gradually, the here this x axis is thickness y axis is load thickness reduces gradually, and after reaching a certain load the anvil starts moving upward.

So, thickness gradually increases. And, we get different parameters similar to the tensile test as in KESF 1; it is linearity, linearity of compression curve. So, linearity of compression curve we get from that is the value of area under the compression curve, divided by area under the area under the compression curve, and divided by the total area of this triangle. Triangle AT_0Tm this is the T_0 is the initial thickness and this is Tm is the final thickness so, AT_0Tm this triangle. So, if this curve it is it follows the straight line curve then it would have been 1 ok.

So, linearity of the compression curve is area under the compression curve divided by this area of this triangle. And, WE is the compressional energy which is nothing, but the area under the compression curve ok. Compression curve and RE is the compressional resilience, RE is the compressional resilience which is the area under the recovery curve by area under the compression curve. So, that way we can get all the data.

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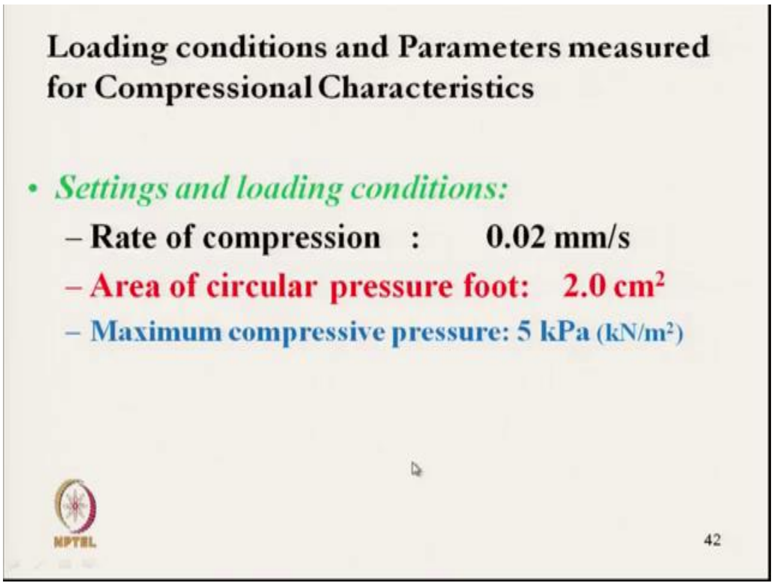

So, here the setting and loading conditions are the rate of compression is recommended as 0.02 mm/s, area of circular pressure foot is $2 cm^2$, maximum compressive pressure we can achieve, we can have here 5 kPa, which is not that high normally.. That is why it is a low stress mechanical characteristics which is used for to access the fabric handle characteristics ok, 5 kPa.

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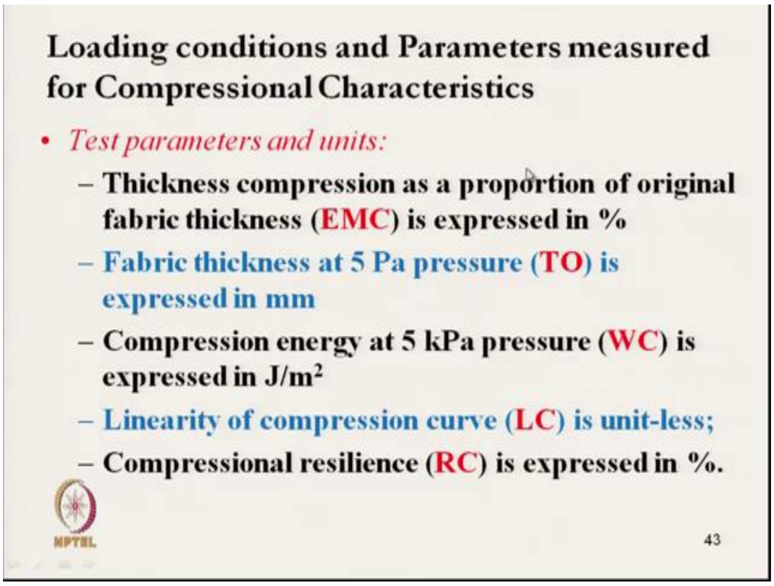

And the test parameters, which we get here the thickness compression as per the proportion of original fabric thickness EMC is expressed in terms of percentage. So, EMC we can get which is actually as per the initial thickness. Fabric thickness at 5 kPa pressure is TO is expressed in terms of mm, compressional energy at 5 kPa pressure is WC is expressed in terms of J/m^2. And, linearity of compression curve LC is unit less because it is a ratio of area and compressional resilience RC is actually expressed in terms of percentage.

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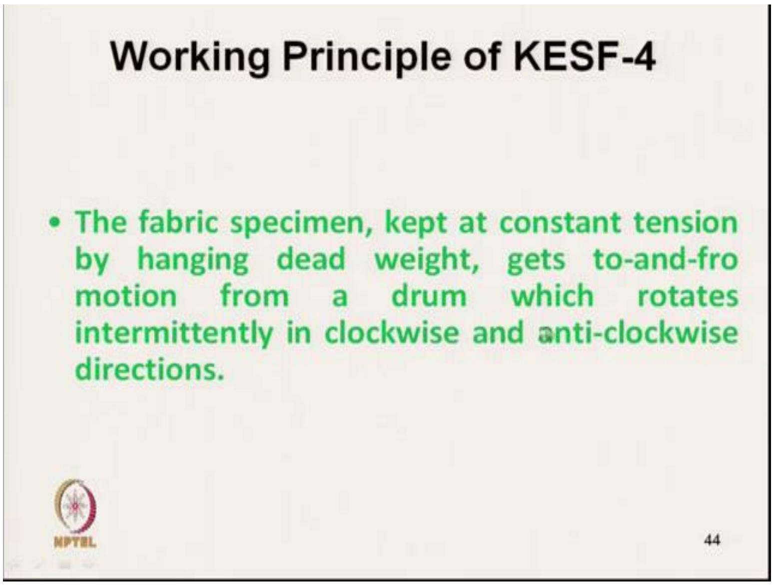

So, all these parameters we can get from the compression and recovery curve. And, the last module of KESF is the KESF 4, where we measure the surface roughness and frictional characteristics. The fabric specimen, kept at constant tension by hanging dead weight.

So, fabric specimen we have to keep at constant tension, we cannot leave it loose otherwise we will not be able to measure the surface characteristics because fabric specimen has to be straight, and gets to and fro motion from the drum which rotates intermittently in clockwise and anti-clockwise direction. So, that the fabric initially fabric we have to keep it tight by hanging certain dead weight and one side it is hanging dead weight is there, another side it is kept it is fitted on a drum and the as drum rotates the fabric makes movement.

Drum rotates clockwise and anticlockwise direction. So, fabric also makes to and fro motion in this way.

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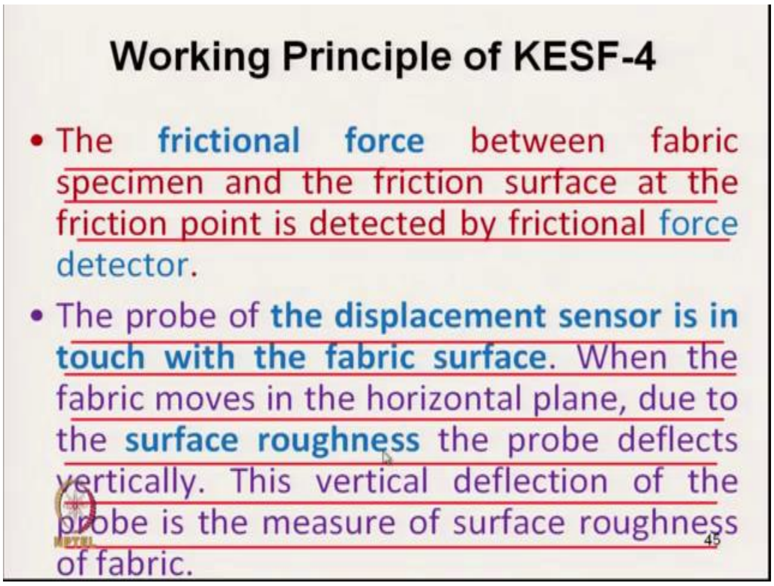

The, frictional force between fabric specimen and a friction surface so, there is a specific friction surface is there at the friction point is detected by the frictional force detector. So, there is 1 point which is frictional force detector is there, there is a force detector is there so, which measures the frictional force.

The probe of displacement sensor is in touch with the fabric surface. So, one is that frictional force detector, another sensor is the, which is the displacement sensor, which sense the fabric roughness. As the fabrics like this is the fabric the displacement sensor is placed just it is a kept on the fabric surface ok.

If the fabric surface is smooth there is no there is a nothing it is a totally it is a smooth surface. Once the fabric is moving, the displacement sensor will not make any vertical movement, but if the fabric surface is rough.

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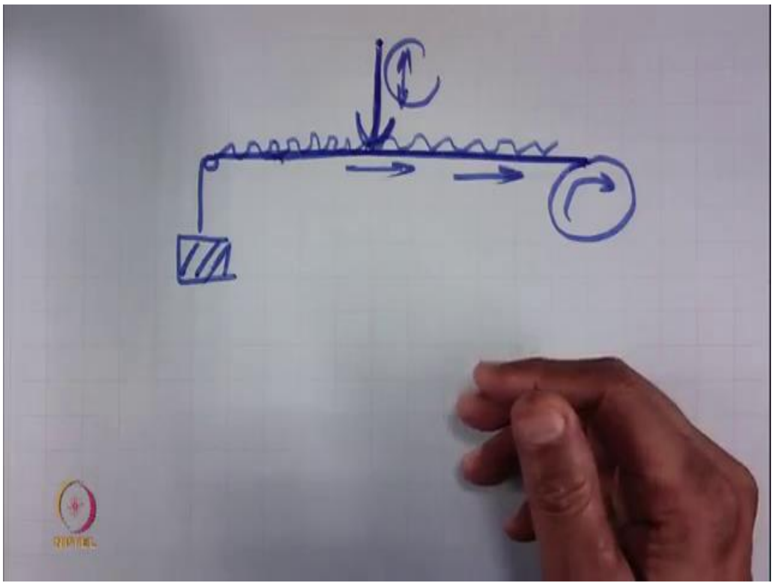

Now, let us see this is the fabric surface and displacement sensor is kept like this it is placed on the fabrics. And, here this side the load is hanging dead weight is hanging and other side it is connected with the drum. Once drum is rotating the fabric will make movement and suppose this fabric is totally very very smooth.

So, there would not be any deflection of this displacement sensor. So, this will be stationary it will simply slip on this ok, slide on this fabric will simply slide, but suppose a fabric is rough one. So, in that case this displacement sensor depending on the roughness this will make up and down movement. This movement is recorded and this will show the surface roughness characteristics.

That means the probe of displacement sensor is in touch with the fabric surface, when the fabric moves in horizontal plane due to the surface roughness the probe deflects vertically. If, the fabric surface is perfectly smooth there would not be any vertical deflection. This vertical deflection of the probe is the measure of surface roughness of the fabric. So, once is that the frictional force is detected another is the deflection is detected. So, we measure the both the frictional characteristics and surface roughness characteristics of fabric.

So, the KESF actually measures the surface related characteristics.

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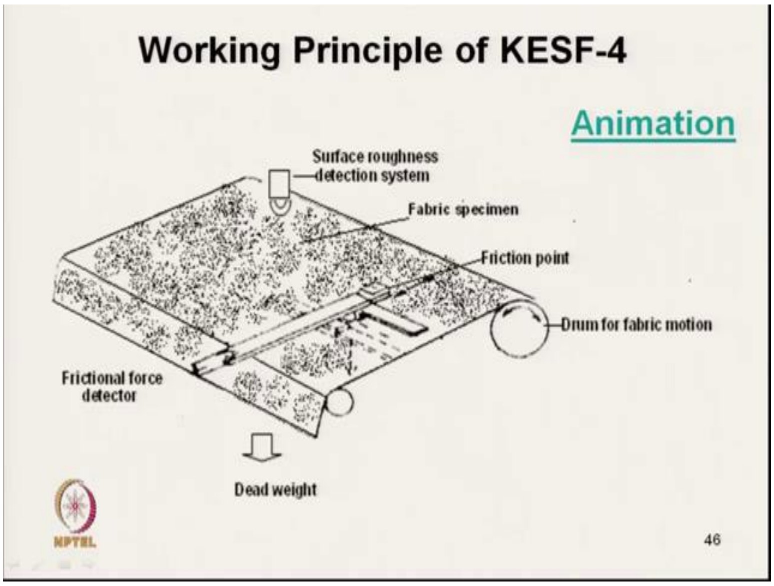

Now, this is the schematic diagram where this one is the fabric specimen, dead weight is hanging to keep the standard tension, certain tension. And, here it is a friction point it is connected with the rod which is connected with the friction force detector ok. And, another point here surface roughness detector as I have shown which detects the deflection. Now, once the drum is rotating clockwise direction. So, other side is a free this can simply move up and down ok. Once this drum is rotating in clockwise direction, there will be of friction generated at the frictional point and this friction force is measured by the friction detector.

And, when the fabric moves in other direction that is the rotation of the drum is in the other direction there will be another frictional force. So, this detector, force detector it works in compression mode and extension mode. Once the fabric is moving in the right direction that is the drum is moving in clockwise direction, this friction force detector works on the extension mode.

And, once the fabric is moving in left direction, from right to left that is the drum rotates in anti-clock wise direction this force detector works on the compression mode.

So, the we can get both the data ok. And, similarly during this movement we get another signal depending on the surface roughness, this detector surface roughness detector moves makes the deflection vertical deflection and we get the surface roughness value.

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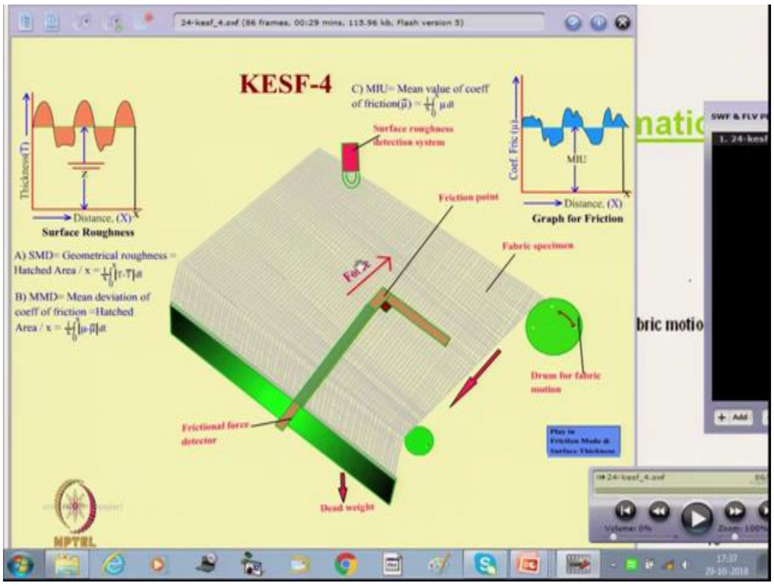

Now, let us see the animation for this. Now, once we start like drum is rotating clockwise direction. And this is the surface roughness and here is the friction. You can see that it gives the friction value depending on the direction ok. Once it is moving compression it is in the compression mode it is giving in the other direction in this way it gives ok. And, here depending on the deflection we get this curve.

In X axis it is a distance travelled and Y axis it is a thickness, the variation in thickness we can get from this curve and variation in coefficient of friction. In X axis it is a deflection distance travelled by the fabric and Y axis the directly we get the coefficient of friction if we know the normal force ok. So, we get the geometrical roughness value by the hatched area, area of the hatched portion, if we get, it is the geometrical roughness value ok. And, mean deviation of coefficient of variation this is the area of hatched portion. So, that from there we can calculate the mean deviation of the friction that is MMD and also we can calculate the mean value of friction which is MIU.

So, from there we can calculate the mean value if we have individual data. So, from this technique, from this module we get 3 parameters; one is SMD which is geometrical roughness, MMD which is the mean deviation of friction and another is the mean value of coefficient of friction which is MIU. So, all 3 parameters as we know that these are related to only the surface characteristics of the fabric ok; that means, higher the roughness, higher will be the SMD because higher will be this area ok. Similarly, that the MMD mean deviation of coefficient of friction is extremely important to judge the whether the fabric is a touch it is a scroopy feeling, whether there is in stick slip mechanism that will give the value.

That will give the value higher MMD value will show the scroopy feeling.

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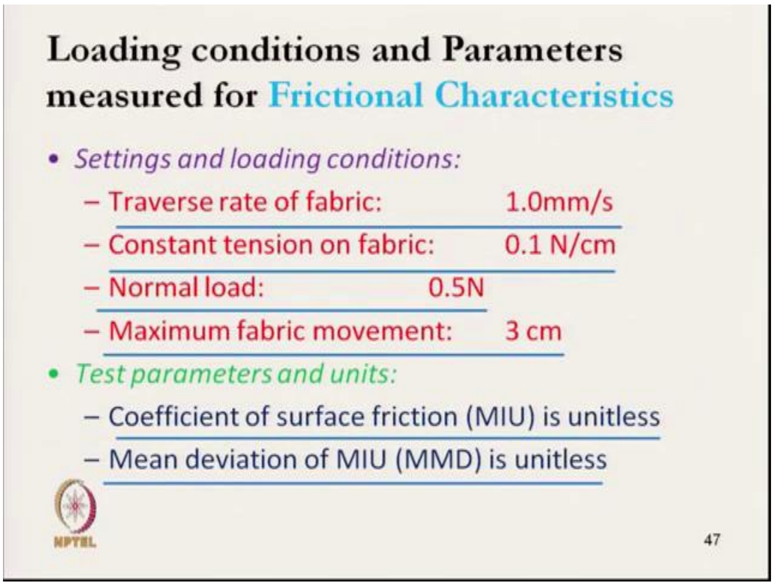

So, let us see the loading condition and parameters measured for frictional characteristics. The setting and loading conditions are the traverse rate of fabric is 1 mm/s that is a traverse rate by rotating drum, constant tension on fabric is 0.1 N/cm that is the dead weight we use normal load which is applied at the friction point 0.5 N that is a normal load it is a very small load is applied and maximum fabric movement is 3 cm. So, that 3 cm it moves in that is the maximum movement and test parameter, which we get on a frictional module as I have mentioned coefficient of friction MIU, which is unitless which is and another is that mean deviation of MIU which is MMD again it is a unitless ok.

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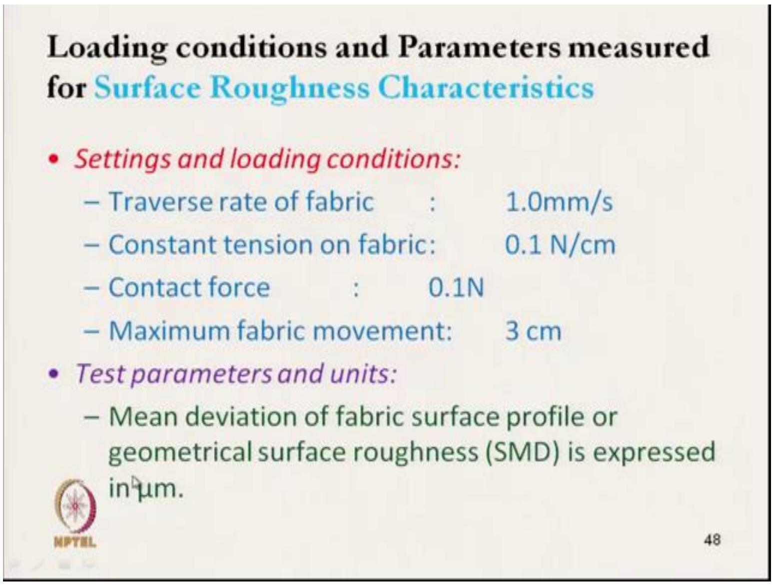

And, for surface roughness characteristics the setting is the traverse rate of fabric is exactly same because the same module we are using, and we are testing in the at the same time at the constant tension is again same point 0.1 N/cm. So, we have to maintain the same constant tension, if you do not maintain the tension here the problem will be that the fabrics wrinkle will show off in the result.

Which will give wrong result and constant force which is applied 0.1N. So, here we measure impart the constant force on the displacement sensor 0.1 N, it cannot it should not be too high because otherwise it will compress the rough portion also. So, we need a very small weight and at the same time we need for certain load to keep a contact with the fabric sample specimen. And, maximum fabric movement again it is a 3 cm, it is exactly same to that of friction. And, the test parameters and units here we get the value mean deviation of fabric surface profile or geometrical surface roughness SMD which is expressed in terms of µm.

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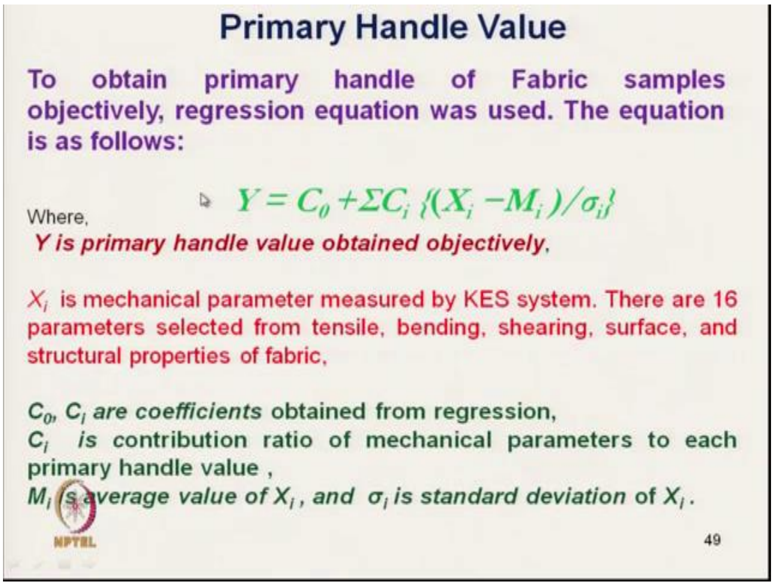

Now, from all this parameters, if we have which we have seen in Kawabata we get 16 different parameters from all this modules. And, ultimately this, all this parameters are used to evaluate to judge the fabric handle value. So, primary handle value we can get we can extract from all this parameters. So, to obtain the primary hand of fabric sample objectively, a regression equation was used. Initially it was used by Kawabata and subsequently it has been modified for different types of fabrics and the equation is of the form of this is the form where Y is primary hand value obtained objectively. So, there are different types of hand expressions.

I will just mention I will give some example. And Xi is the mechanical parameters measured by KES value. So, Xi we have seen we have seen a various mechanical parameters related to tensile, shear, compression, bending. So, these are the individual parameters Xi ok. There are 16 parameters selected from a tensile, bending, shear, surface, characteristics, structural properties of fabric C_0 and Ci are coefficients obtained from regression. So, these are the different parameter this coefficients which are obtained from the regression equation Mi is the average value Xi is the individual value and this σ_i is the standard deviation of Xi.

This is the standard deviation. So, using this equation we can get the primary hand value. So, I will give some examples now.

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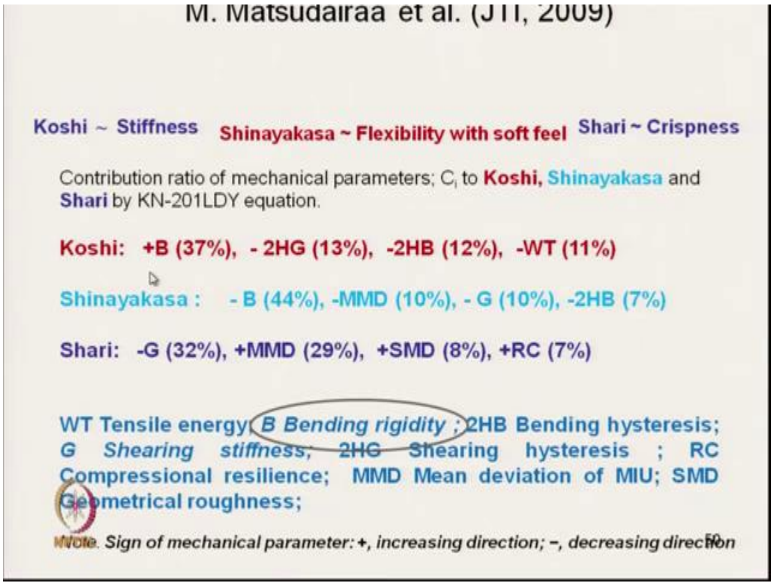

Suppose this is the, these are the different hand expression like Koshi, Shinayakasa Shari. Koshi means it it is actually not exactly the stiffness, but direct it is related to stiffness of fabric, it is not directly the bending stiffness, it is related to the stiffness, it has a related to other characteristics also. Similarly, Shinayakasa it is not just opposite to the bending it is not the directly flexibility. It is a flexibility with soft feeling and Shari it is a crispness some crisp feeling.

So, that all this handle primary handle related characteristics we can get from the values, primary hand values, like some mechanical low stress mechanical characteristics we can get from this value ok. Now, Koshi, if we see the stiffness it is related with the B, what is B? Here B is the bending rigidity of the fabric.

So, it is actually positive means it is a positively related increasing direction, it is increases with the increase in B value; that means, and its weightage is 37 percent. So, it is 37 percent positively related; that means, as the bending rigidity of fabric increases the Koshi value increases ok.

Similarly, the 2HG and 2HB and WT they are negatively correlated, with the Koshi. What is 2HG? 2HG is the shearing hysteresis. So, it is a shear hysteresis 2HB bending hysteresis. So, as the shear hysteresis or bending hysteresis increases the Koshi value reduces.

Similarly, WT tensile energy so, as the tensile energy increases, the Koshi value reduces; that means, it should be stiff enough, but the tensile energy should be less. So, we will get the higher Koshi value. So, that way we can interpret the primary hand characteristics using the value which we have got from the KESF testing.

Similarly, Shinayakasa which is a flexibility with soft feeling what is flexibility? Flexibility in terms of shear stiffness; that means, the higher shear stiffness will result lower Shinayakasa; that means, we if we want to have higher flexibility. So, we have to have lower G value that is shear stiffness. So, a fabric with lower shear stiffness will give higher flexibility.

So, that is why it is a this is related to with this is not that related with Koshi, B value, but Shari is the crispness. What we have I have discussed now it is a Shari and Shinayakasa, which is flexibility with soft feeling which is equal to that it is a inversely proportional to the bending rigidity, it is a 44 percent it is related with the negatively related with the bending rigidity; that means, B if the stiffness is high.

The Shinayakasa will be low it is a; that means, it is making the fabric flexible. Similarly, MMD value mean deviation of MIU if it is high higher mean deviation of MIU will give lower Shinayakasa. So, it is negatively related it is negatively related with the G value it is a shear rigidity that means, higher shear rigidity will give lower Shinayakasa value ok. So, that is how. So, higher Shinayakasa means higher flexibility of the fabric. Similarly, Shari, Shari is the crispness of the fabric if we see the crispness it is if the fabric shear stiffness is high; that means, it will be less crisp value.

So, crispness we are getting from the G value that is shear stiffness that is it is negatively correlated, very highly positively correlated with mean deviation of MIU; that means, a fabric with high mean deviation of MIU will have crisp value; that means, the coefficient of variation is changing that is that is why it gives the crispness value. And, also it is related to some extent with SMD and RC. RC means compressional resilience.

So this are the values which are actually significantly related with the this parameters there are other parameters which are not that significant. So, these are the significant parameters; that means, the primary hand value, primary hand expressions we can get from the basic parameters, which we get from the Kawabata evaluation test. So, these are the primary values which we have got. Now, we will discuss the next module, next type of instruments which is FAST, fabric assurance by simple testing.

Now, we must understand the basic difference with the Kawabata system. In Kawabata system, which we have got as I have mentioned earlier the tensile side or loading side and unloading side we get the data entire data from each and every point through the transducer. So, the sensors which we get which supplies individual data, and also we get data from loading direction as well as in the unloading direction, but the FAST system it is very simple.

Here we get a discrete value discrete point ok.

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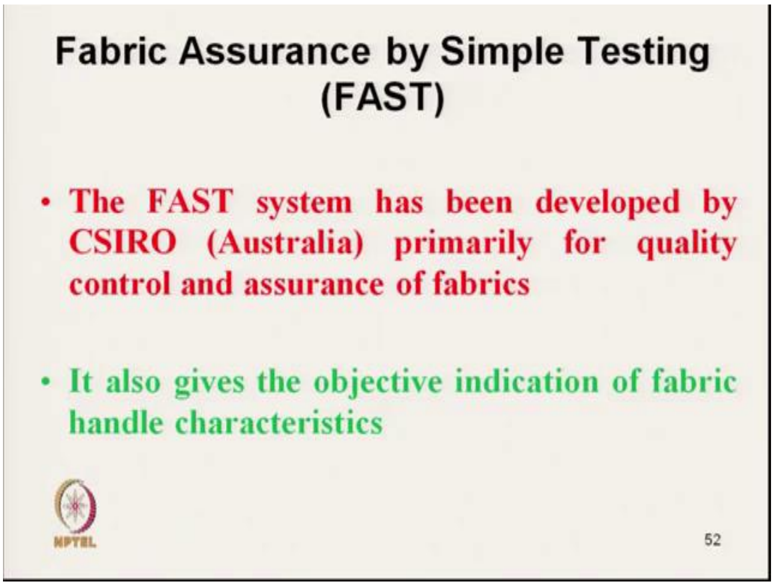

So, it has got it is developed by the CSIRO Australia, it also gives the objective indication of fabric handle characteristics.

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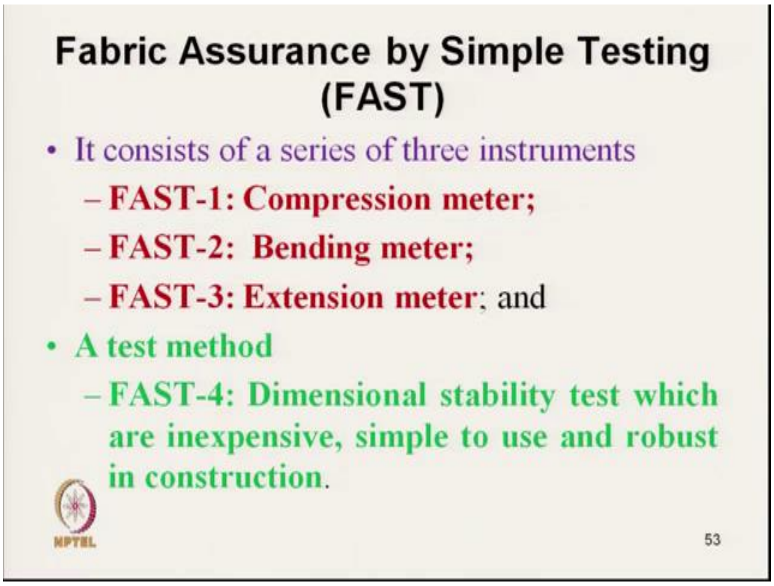

The, it consists of series of 3 instruments. So, it has got 3 module; FAST-1 which is compression meter; FAST-2 which is bending meter, which is similar to the shirley stiffness tester, and FAST-3 it is extension meter. These are the 3 instruments in addition to this 1 test method is there which is FAST-4 a dimensional stability tester.

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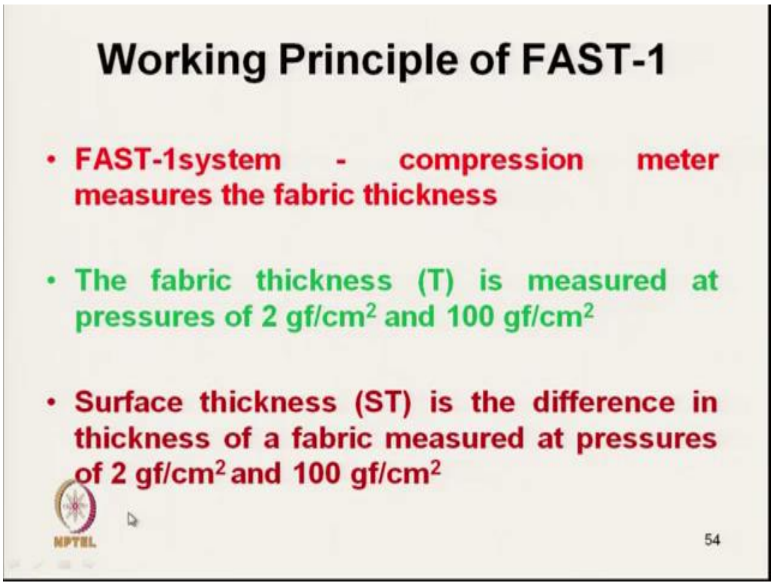

So, we will start with FAST-1. So, in FAST-1 compression system which is, which measures the fabric thickness. Although, this instrument apparently looks very simple.

But, the type of data, which we get type of information which is get it is very nice. The fabric thickness T is a measured by the some pressure foot which is measured at the pressure of 2 gf/cm^2, and as well as 100 gf/cm^2. So, there are 2 pressures at 2 pressures we measure the thicknesses. And, the surface thickness ST is the difference in thickness of fabric measured at pressure 2 gf/cm^2 and 100 gf/cm^2. Now, let us see the difference between this FAST system and the Kawabata system.

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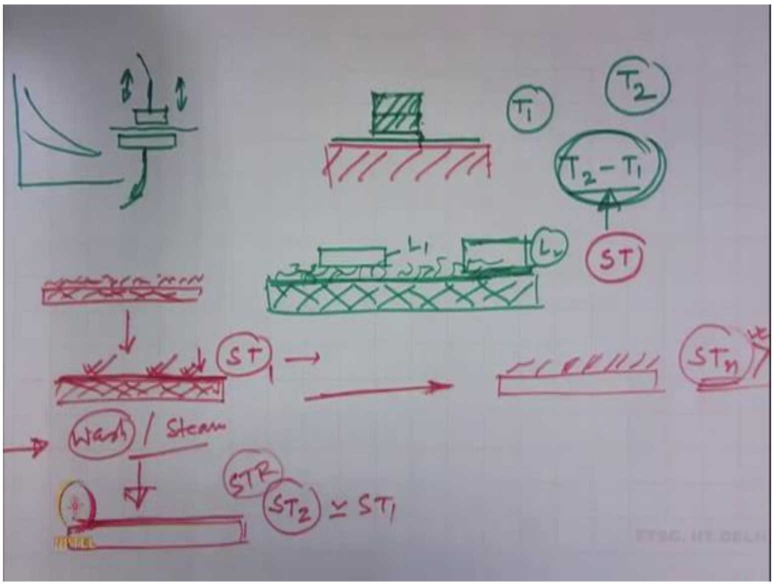

In Kawabata system this was the anvil and fabric sample was there and pressure foot. Pressure foot was moving up and down and we are getting data from the pressure that is the movement of the pressure foot and the load cell with the anvil. So, we get both the loading elongation that is compression and recovery curve, but here the system is very simple, this is fabric specimen placed on a table it is, a table fabric specimen here. And, it is loaded with the certain deadweight and we measure the thickness here and then we increase the load at certain.

So, initially there was a smaller load, and other then we have increase the load, and we measure so, T1 is the initial thickness and then after higher load it is T2. And, this difference between T2 and T1, we measure and this is actually surface thickness what is surface thickness? Suppose this is the fabric it has got some hairiness on the surface. So, initially at lower load we measure the thickness. So, at load 1 and once we increase the load, suppose once we increase the load this hairs will get compressed, mainly this hairs will get compressed. Initially there was no compression of the hair, deflection of the hair after and the load is not that high which will not basically deform the fabric.

This load L2 will deform the hairs only; that means, the difference is T2 and T1 it is not the deformation of fabric, it is a deformation of the hairs. So, that is how this difference it is called surface thickness which actually indicates the hairiness of the fabric surface. So, the surface thickness ST is the difference in thickness of fabric measured at pressure of 2 gf/cm^2 and 100 gf/cm^2. It measures the basically, it indicates the hairiness characteristics of the fabric, surface hairiness.

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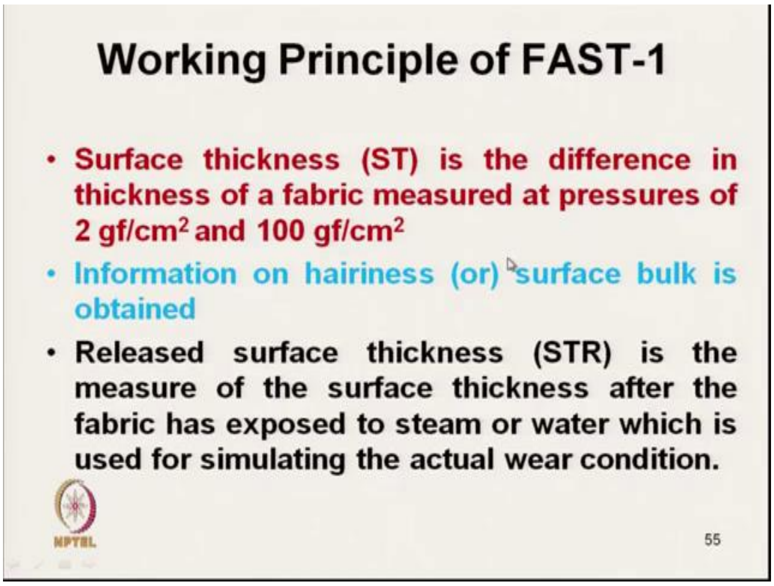

So, surface thickness is the difference in thickness as I have mentioned, information on hairiness or surface bulk is obtained. So, in either hairiness or it is a surface bulk characteristics not the bulk characteristics of the fabric, core. So, this gives the characteristics of hairiness. So, another characteristics from the same parameters that is difference between the thickness at 2 gf/cm^2 and 100 gf/cm^2, we get another parameter which is called released surface thickness STR ok. Surface thickness is released what is that? It is a measure of surface thickness after the fabric has exposed to the steam or water which is used to simulate the actual wear condition.

Now, we must discuss here this part ok. So, we have got the surface thickness as I have mentioned. Suppose this is the fabric original fabric sample ok. Original fabric samples with some hairiness some surface bulk or say hairiness. Now, what we have done we have actually coated the fabric. This fabric is coated with some coating material. And, where this is a coating material, where the hairiness all this hairiness have come under this coating let us say. Now, here if we measure, the surface thickness ST we will get a value say ST1 and after that we wash the fabric or steam treatment.

Steam treatment we are giving or washing so, which is simulating the actual wear condition. Suppose this, the finish which we have applied coating finish or finish we have applied, which is permanent which is not washing out. What will happen? This fabric, will the surface will, remain intact ok, hairs will not come out and we will get value ST2 which is almost equal to ST1, very closely equal to ST1. Another fabric suppose, now we are we are keeping on washing, and we are laundering and we are doing what happen this finish will come out, finish will come out gradually and this hairiness will again come out show off.

That means and again we are testing STn after nth wash this STn will be more than ST1 or something. So, the difference in the surface thickness and this surfaces thickness it is called it is a released surface thickness STR. So, released surface thickness and initial surface thickness, this difference will show the, how well we have actually finished the fabric. If the finish of the fabric, is perfect, if it is permanent, then the release surface thickness and surface thickness value will be exactly same or very close. If the release surface thickness, is more much more than the surface thickness, then it will show that the after exposing the steam or water, which is simulating the actual wear condition, the fabric is actually losing it is finish, the finish is not permanent.

So, we can, see from a very simple testing of thickness, with 2 different pressure, we can get idea of fabric surface characteristics. And, also this surface thickness, will give us idea about the touch of the fabric. If it is whether there is a hairiness are there or not whether surface bulk, is proper or not, we will get idea about the this characteristics through the surface thickness.

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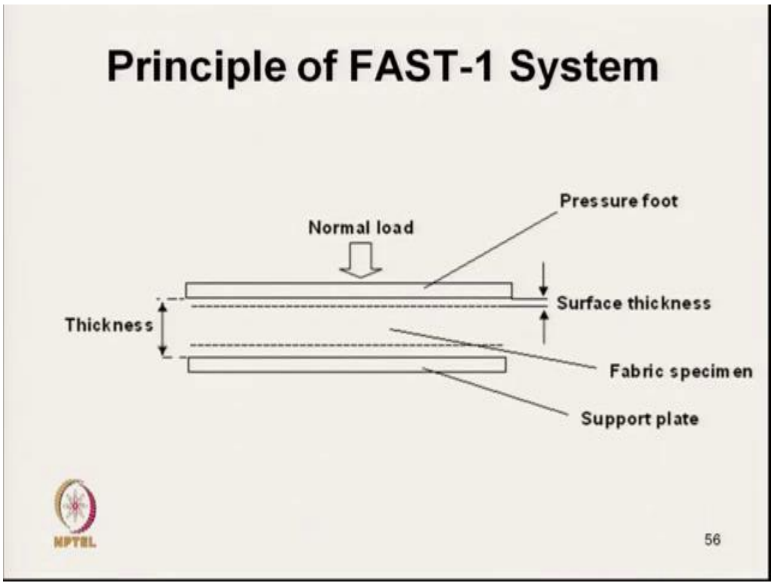

So, the principle, is that it is a simple principle it is a normal load, a pressure foot is there and normal load we are applying, this is the fabric and here is the surface thickness only at the surface level where it is compressed.

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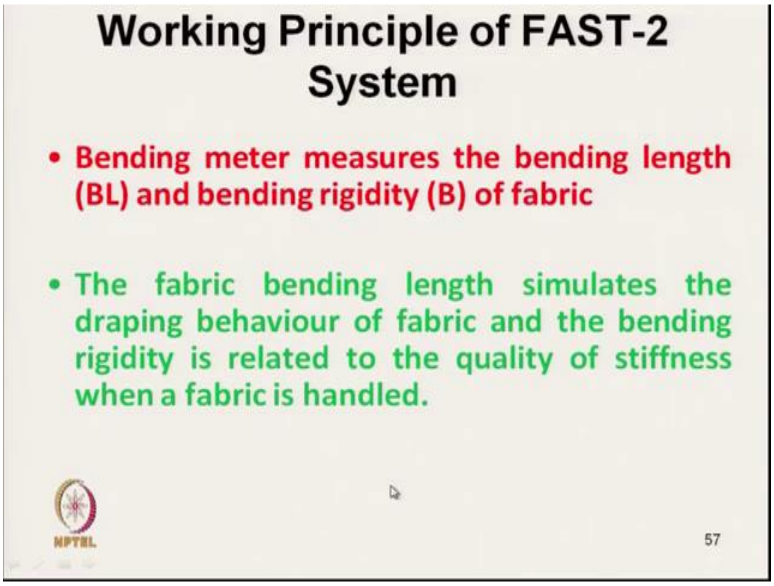

And, the next method it is a fast 2 method which is bending meter. And, bending meter measures the bending length and bending rigidity of fabric. The bending length and bending rigidity, it is exactly same as the Shirley stiffness tester, the fabric bending length simulates the draping behaviour of fabric and the bending rigidity is related to the quality of stiffness, when a fabric is handled ok. So, that is how we get the fabric handle characteristics.

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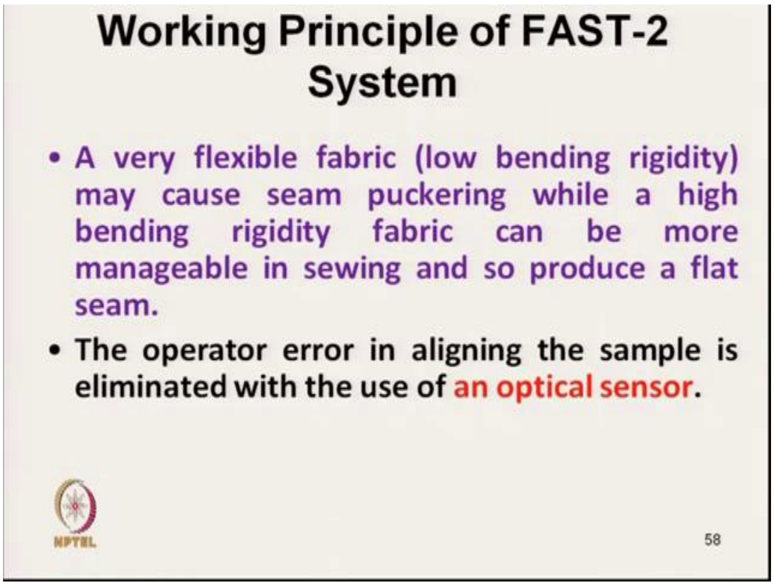

A, very flexible fabric, that very low bending rigidity, may cause seam puckering while a high bending rigidity fabric, can be a more manageable in sewing and so produce a flat seam.

So, it gives idea about the seam puckering and stitching condition, sewability of fabric the operator error of aligning the sample. So, here one optical sensor is used, while aligning the sample, sometime the test during testing, the alignment if it is wrong, that will give us wrong result, here optical sensor is used for proper alignment of the sample ok.

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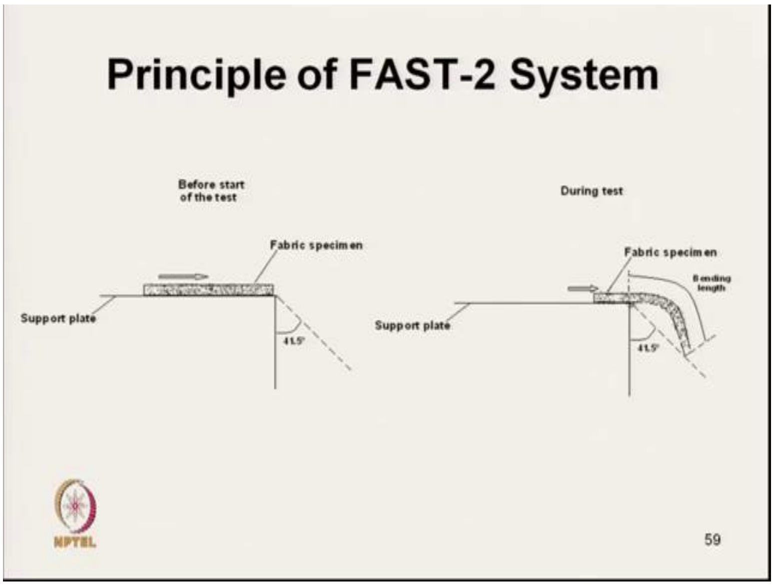

The principle, as I have mentioned it is exactly same as the Shirley stiffness tester which we have used earlier, the angle here which is used same as Shirley stiffness tester 41.5 degree. And, we measure the overhanging length and from there from overhanging length, we calculate the bending rigidity of the fabric. So, we will stop here for today we will continue with this FAST testers FAST-3 system in the next class till then.

Thank you thank you for patient hearing.