Science of Clothing Comfort
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Lecture - 20
Tactile Aspects of Clothing Comfort (contd…)

Hello everyone, and last class we have discussed the fast system of measurement of fabric handle characteristic. So, we have mentioned that two commercially available fabric handle characteristics measurement systems are there- one is KSH, another is fast. Today will discussed another method of measurement which is fabric handled by or for fabric feel by extraction principle.

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So, it is not very new, it is actually it is a very common practice to know the fabric softness or fabric handle for many years using the extraction principles ok.

So, it is actually it is useful technique to judge the fabric handle, it is a quantitative value we get, very old techniques among the ladies where the fabrics are been pulled particular scarf or any soft type of fabrics are been pulled massing through the ring and judging the overall load required to pull the fabric ok. So, this similar technique similar principle is being used here to know the fabric handle or fabric feel related characteristics.

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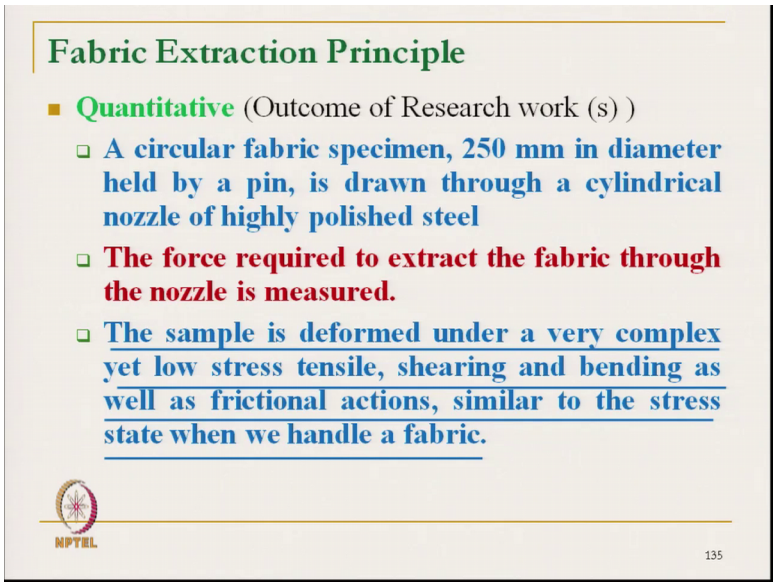

So, this system this principle is not new. So, here the circular fabric of 25 centimeter diameter is actually held by a pin at the centre, and is drawn through a cylindrical nozzle highly polished nozzle, made up may be steel may be any other material may be plastic. The force required to extract the fabric through the nozzle is measured ok. And the sample here while pulling through the nozzle, the sample is deformed there is a complex deformation at low stress level where is that may be tensile deformation may be shearing deformation may be bending deformation there are action of friction between the nozzle surface on the fabric.

So, all complex deformation takes place during the pulling and which ultimate which are actually related with the fabric handle characteristics, and all this different types of deformation gives one unique value of the pulling force and from this pulling force, we can get idea about the feel of the fabric.

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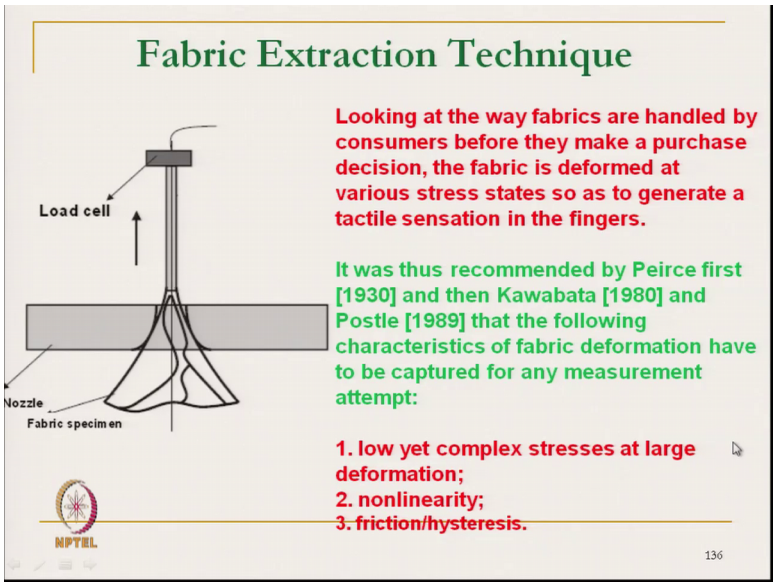

So, the principal here is that, it is a there is a nozzle its nozzle is there, it is a hole is there and this is the grip at this point it is griped at the centre. If it is a surplar fabric and the fabric is pulled through this nozzle.

And the load cell detects the amount of load amount of load; during the pulling layers and as I mentioned this system this principle is of measurement. It is exist for a long time, but this nozzle extraction principle is also not new ok. It is actually proposed in say in 1930s, but Peirce who has proposed this principle first, then Kawabata proposed in 1980s then Postle who is who has proposed this principle is 1989 that the following characteristics of fabric deformation have to be captured by measuring the force. This is a measurement at the by low yet complex stresses at large deformation.

So, yet large when we keep on the pulling the fabric at large deformation, this low and complex stress we can measure which is non-linear in nature and the frictional friction and hysteresis we can measure.

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So, the present approach which we have adopted here, it is a our idea is to measure fabric handle or fabric feel with simple and quick measure objective assessment and it should be user friendly. There should be a single value of fabric feel value that we have developed we have got fabric feel factor that we will discuss here. And this feel factor we have measured compared with the subjective assessment. So, single value getting single value was our objective and one real time graph, we can get while pulling we will get a real time graph of pulling force and displacement. We can test wide range of fabric from very stick fabric to very flexible fabric, we can measure in the same instrument, and moreover this instrument should be as simple as that unskilled and unskilled shop floor worker can handle. Because this is this using this fabric one can compare the softness characteristics of fabric and the instrument should be cheap enough and so, that small scale industries, they can afford.

Other instruments commercially available instrument we have seen, this instruments are very expensive. So, we cannot the industries normally they cannot afford and next another problem is that those instruments are so, complex the actually measurement is very complex. So, the repeatability is very difficult and analysis is difficult. So, this approach was that it is a simple instrument unique data should, we should get and it will we should get unique value so, that it gives the fabric handle.

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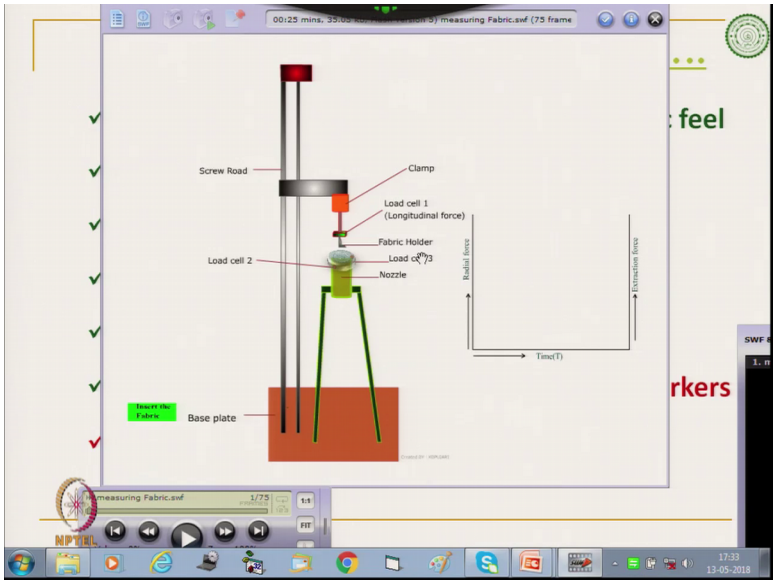

So, the approach we can if you see, here with the animation if you see, this is the nozzle its ring type nozzle. Here it is a fabric holder this one is fabric holder which is connected with the load cell and there is a clamp which is holding the load cell and there is a traverse arrangement. This is the holder, it is a cross head which moves up and down and the fabric after cutting its placed through the nozzle and grip by the fabric holder. And as the and the nozzle has got it is special type of nozzle which has got two extra load cells ok.

In case of when if extract fabric will have a longitudinal load, which is sensed by the load cell 1 and also during extraction it exacts redial force that radial force that is measured by 2 load cells 2 and load cell 3; two redial direction force. And we get total picture of the load value during the extraction.

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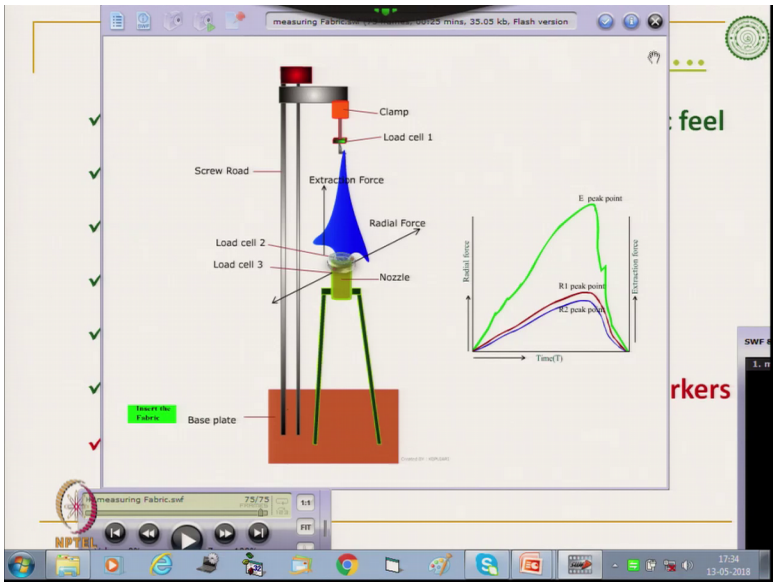

Now, let us see this is the fabric sample which is first inserted through the ring and it is griped by the fabric holder. This is the placing of the fabric. Now when we start the nozzle extraction, the x axis is the its a time and here this is the radial force and this is the extraction longitudinal force.

So, that so, this is the load cell 3, 2 at extraction is taking place. So, we will get we get three different graphs. This is from the load cell 1 the extraction at peak; this is the radial direction 1, radial direction 2 and mean of these two we can get. So, this is the basic principle of this instrument.

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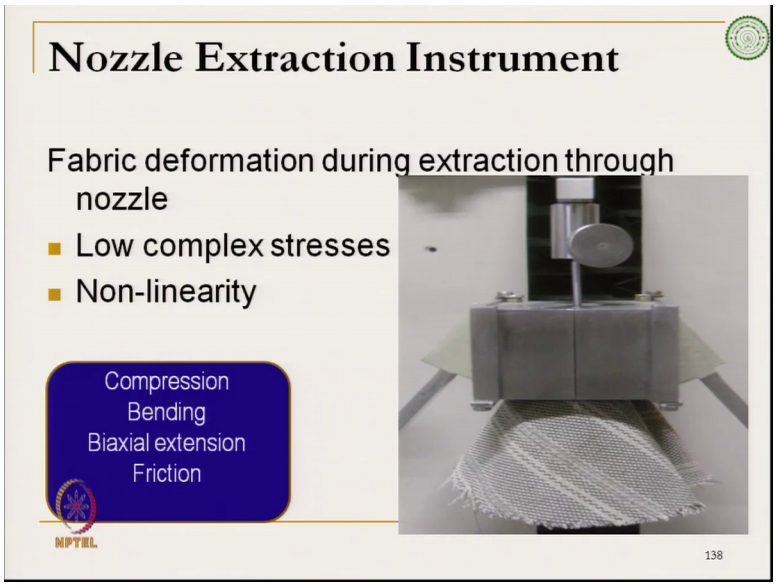

So, this is the nozzle if we can see the picture, this is the nozzle and this is the fabric holder here. This is the fabric sample. So, here as we mentioned it is a compression bending bias extension friction, all complex deformation take place and ultimately we get one parameter complex stress nonlinearity is there.

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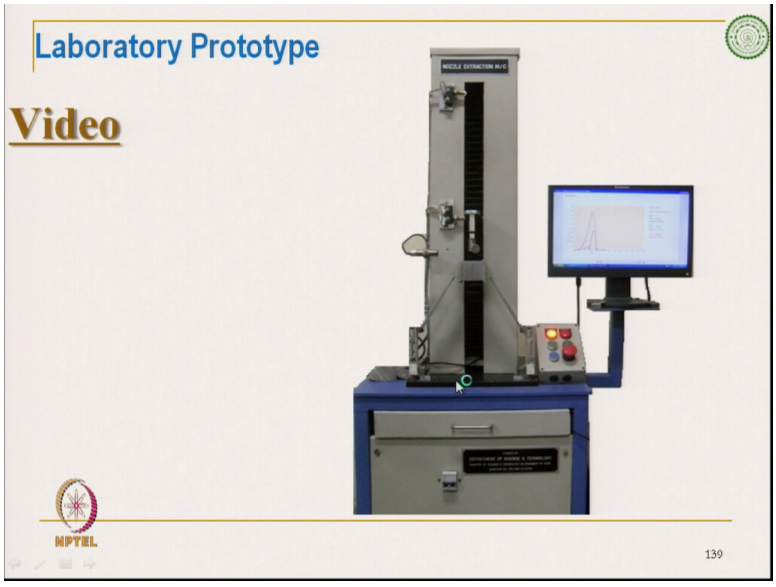

So, this is the proto type of the instrument. So, if you see the video of this testing in the laboratory. So, here if you see that it is a this is the instrument, here this is the nozzle 1 ok.

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Fabric holder and it is a panel it is a nozzle computer monitor is a now the fabric is being pulled through the nozzle and here we are getting graphs; so, extraction force and this graph. So, and now as soon as it is out; so, the test is completed ok. So, we get the complete curve. So, we can so, we have tested. So, different fabrics we can test. This is another fabric. So, different types of extraction force and displacement curve, we get and this, the x axis is a, it is displacement ok.

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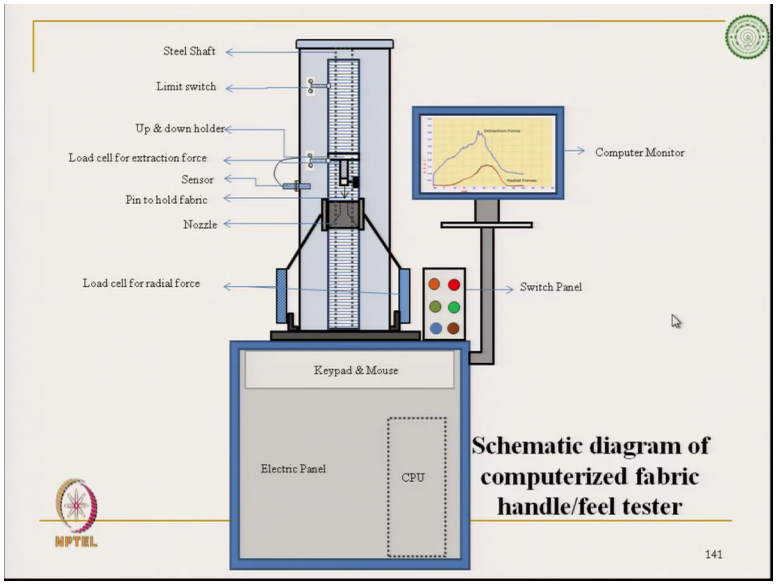

So, this commercial instrument is also available here and these are the different parts as we have explained earlier also.

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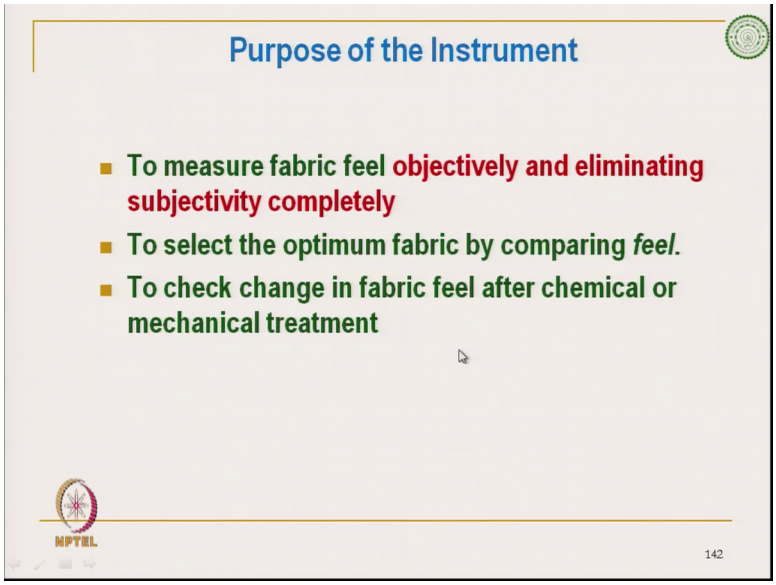

So, the basic purpose of this instrument is to measure the fabric feel objectively. So, we can sense the fabric feel subjectively as we know. So, it is objective measurement of fabric feel. So, it eliminates all the subjectivity, giving one unique data to select the optimum fabric by comparing the feel ok.

If we want to select of fabric, it cannot because that value the fabric feel value or extraction force value, we cannot actually use this value as bench mark. Only thing here we can use this value as to compare with other value other value. So, for example, we have given 10 finish applications, 10 different types of finish for in on a particular fabric ok.

We want to know which finish is the best as far as fabric feel is concerned fabric softness is concerned that comparative value we can get. But if you want to know the, what is the value that value is immaterial here. What is the finish the softness value, that particular that value is actual immaterial. Here we can get, we can get the comparative value. If we have certain number of a 10 different fabric, we can tell out of this 10 fabric which one is softer ok, but that getting a particular specific value. It is immaterial because the extraction force depends on many other factor like fabric which is in little bit stiffer in nature say like denim fabric, we cannot compare denim trouser fabric with fabric cotton

fabric with for a for used for is a shirt. That cotton fabric use for shirt the light cotton fabric used for shirt we will always gives lower extraction force denim fabric will always give higher extraction force, but that does not mean denim fabric is feel wise it is a very hard it is not that.

If we have to compare we have to compare denim fabric and denim fabric. So, that the that is the limitation of this system, but it works with in a particular set of fabric material we cannot compare between different family within same family we have to compare we can tell this fabric is based out of this slot ok.

To check the change in fabric feel after chemical or mechanical treatment. So, that this instrument we can tell after some chemical fabric we have giving some chemical treatment. So, this fabric will give idea about the change in fabric feel that same fabric, but different chemical or mechanical finish if we give, this fabric this instrument will gives idea about the change in the feel of that fabric.

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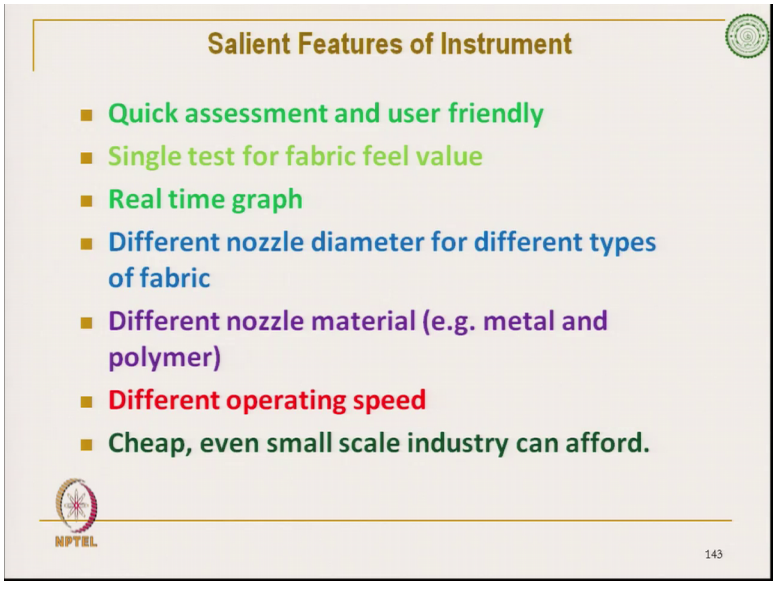

Now, feature that is a that is a quick assessment and its user friendly, it is single test for fabric feel value not like other complex system where large number of test value. We have to (Refer Time: 16:58), we have to test the bending, we have to test the friction, compression, extension then we get certain value, but here we get a single value real time graphs its a gives and different nozzle diameter we can use. Say for very stiff fabric we can use larger nozzle diameter, or a very limp fabric or say knitted warp weft knitted

fabric we can use very small nozzle starch for non oven fabric we. So, wide range of fabric, we can use by changing the nozzle diameter different nozzle material we can use , different operating speed we can change depending on the type of application and the instrument is cheap instrument; this idea was.

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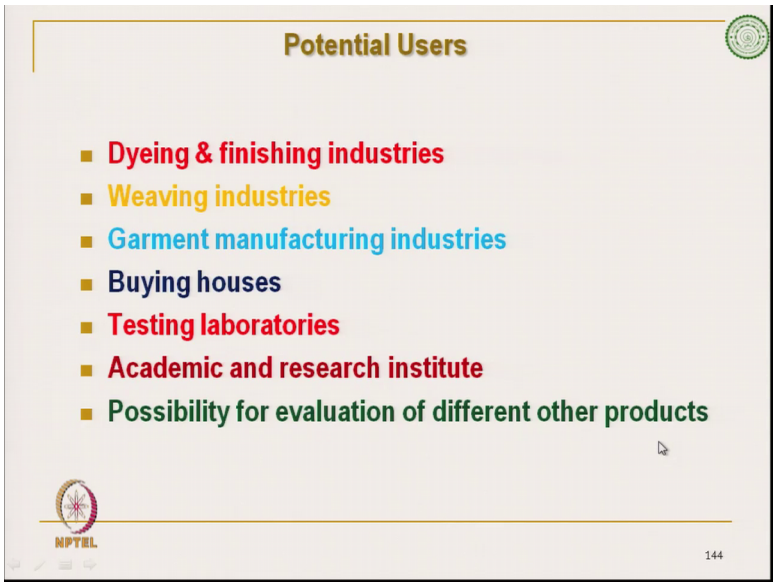

So, the potential users of this instrument is dyeing and finishing industries. If the finishing and dyeing finishing industries, they want to develop some the some particular finish for a better tactile sensation, they can use these instrument ok. After dyeing or after finishing what is the change in fabric feel or fabric handle characteristics, we can this instrument can give idea. The weaving industries, they can set their parameter of different handle characteristics. Garment manufacturing industries, they can use to buy the their row material, the fabric; buying house, they can use; testing laboratories and academic and research institutes, they can use for their research ok.

And it is a possibility of evolution of different other products. So, not only fabric textile material for different other industries one can use. This is say a paper industries or some other industries, this instrument can be used.

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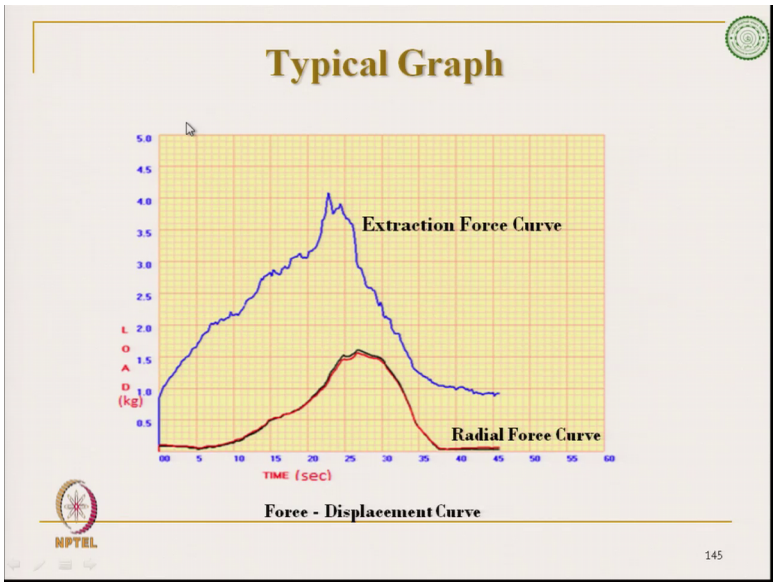

Now, the typical graph has we have seen in the video, this is the typical graph out of the instrument ok. Displacement x axis shows the time and we can convert it to displacement and y axis is the force. This is the extraction force, these are the radial force.

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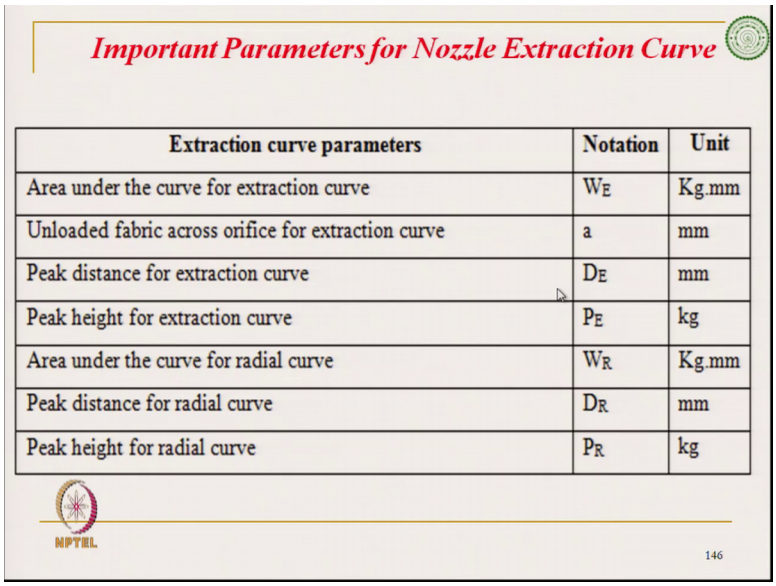

Extraction curve parameters	Notation	Unit
Area under the curve for extraction curve	W_E	Kg.mm
Unloaded fabric across orifice for extraction curve	a	mm
Peak distance for extraction curve	D_E	mm
Peak height for extraction curve	P_E	kg
Area under the curve for radial curve	W_R	Kg.mm
Peak distance for radial curve	D_R	mm
Peak height for radial curve	P_R	kg

And these are the parameters, we can use to develop fabric feel ok. The area under the extraction curve the unloaded fabric across the orifice that is nozzle for extraction a that is the length of that.

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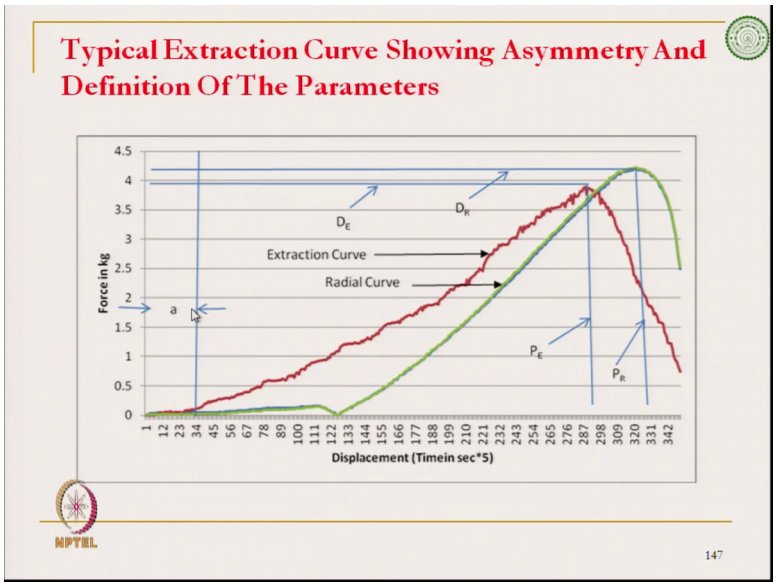

So, I can we can discuss here. So, these are the, this is the length that is the up to this length is a distance there is no load, but there is the a distance. And this is the area under the, a curve that area under the, this extraction ok.

Similarly, the peak distance for extraction curve. So, D E; so, this is the D E extraction curve, this is the peak distance ok. So, radial peak distance peak height of extraction P E. So, area under the radial curve radial force curve peak distance for radial curve and peak height for radial. So, these are the parameters all this parameters are being used to measure the fabric feel factor.

So, using the statistical technique, we have developed one equation which is actually which gives the fabric feel tester, we will discuss ok. So, fabric feel value which is. So, the research study we have carried out.

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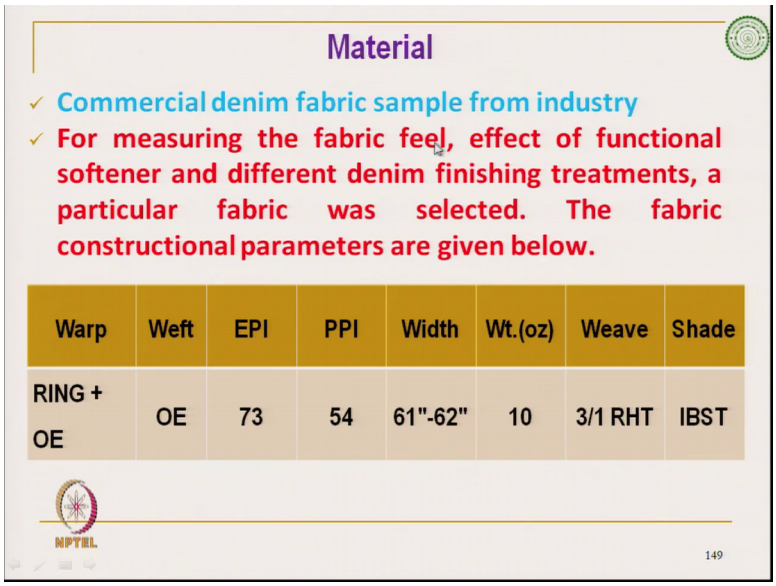

So, the material which we have used commercial denim fabric from one industry, we have used. For measuring the fabric feel, effect of functional softener we have used and different denim finishing treatment, a particular fabric was selected the fabric constructional parameters. These are the fabric constructional parameters ok.

This is an open end ends per inch, pix per inch fabric width and these are the, this is the tweel fabric.

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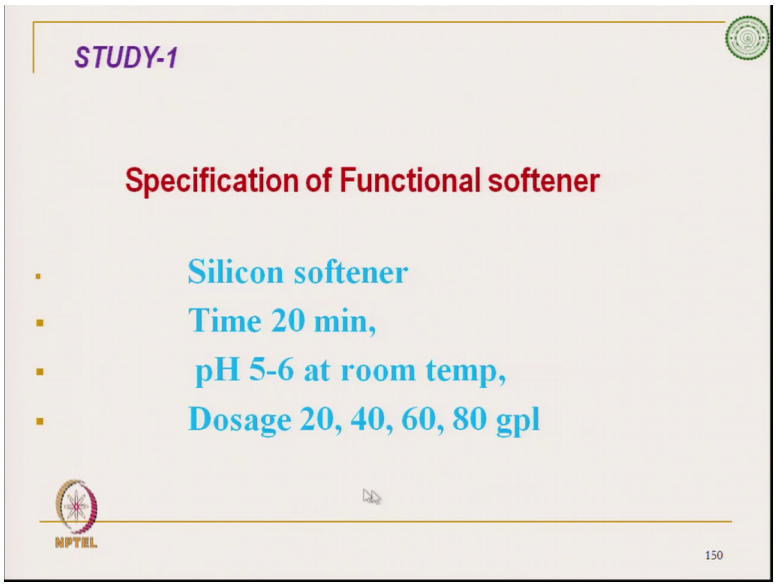

So, these are the different specification of functional softener has been used; silicon softener time p H level and dosage 20 gram per liter 40, 60 and 80 gram per liter these are different dosage has been applied.

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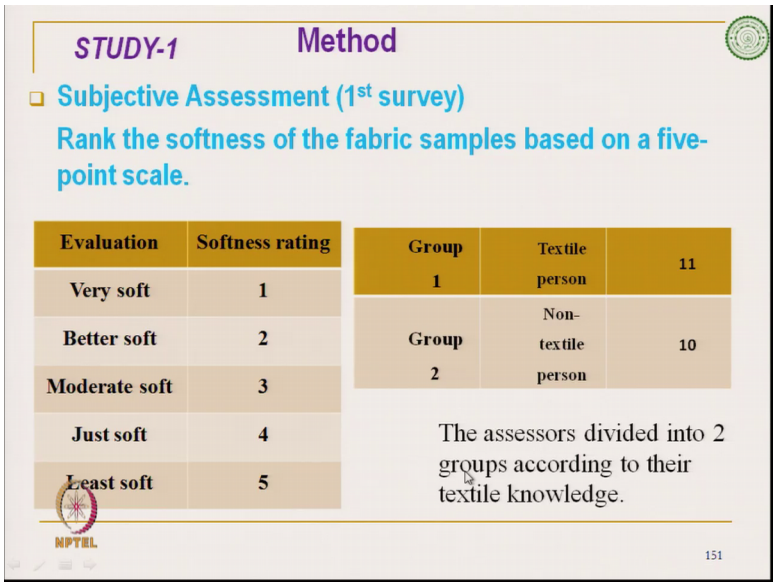

Now, these fabrics have been subjective studied actually assessed. So, subjective assessment it is a basically the five scale point has been rating scale has been provided; the one means it is very soft, 2 it is better than it is softer and 5 is least soft it is hard fabric.

There are actually the evaluators are of two groups. So, textile person who knows about textile there are some knowledge about the textile, the 10 evaluators have been taken and those who does not have any textile knowledge ok. So, they have been 10. So, total 21 evaluators have been used actually. So, they have been ask to rank the material.

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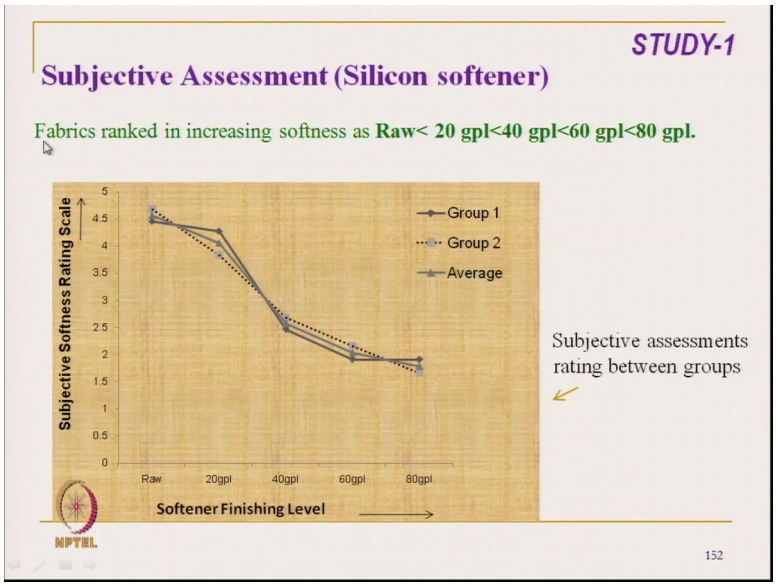

So, this actually fabric rank increases with the, this is the ranking. So, the raw fabric gives the lowest rank. So, as we go on increasing the softener content softener concentration, the ranking increases. That the 80 gram per liter, it gives the highest rank that is by the softness wise it gives the subjective assessment it. It is basically it is a hard fabric actually maximum and this is the very soft fabric.

So, it is it is actually for a different group it gives the uniform rating we got.

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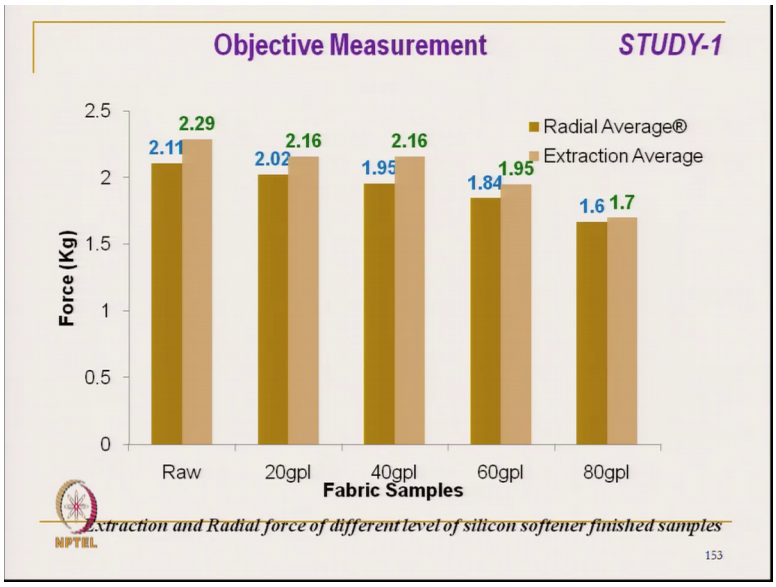

And now the objective rating we have got. So, objective rating its a raw means without any finish without any finish. So, radial average is a radial value radial force we have got and average, that extraction force longitudinal force. So, this we have got this is little bit higher value, and that this is the peak force by the instrument.

So, for 220 gpl 40 60 and 80, so what we have observed? So, with the increase in concentration of the softener, subjectively it has give in the softer feeling which we have got and this is also indicated by the extraction force. So, extraction force is the indicator of the subjective feeling.

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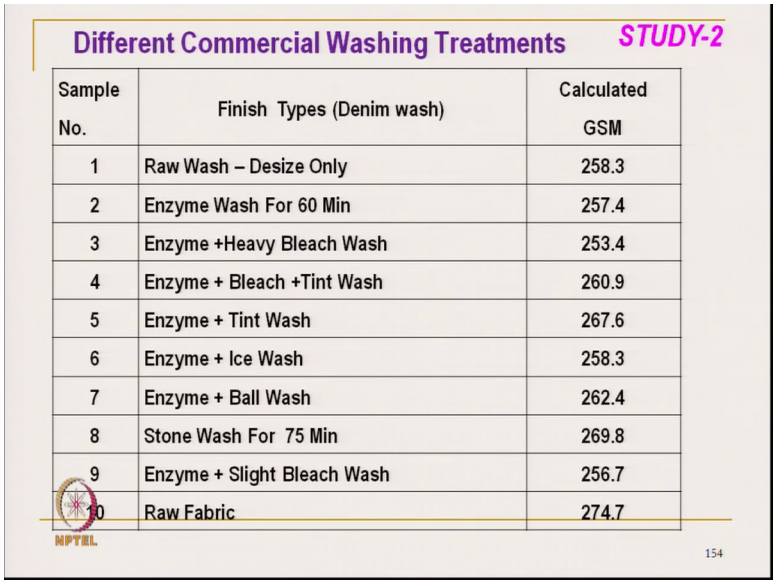

So, but what the basic observation was that, although this is giving indication, but can we get can we get some better indicator which will give us clear idea about the subjective rating subject of fabric feel. So, then we started working on that on the graph ok. And here we have taken 10 different finish and we have taken again denim earlier study what we have used the, we have changed the concentration of a particular finish ok.

But here we have taken 10 different types of finishes which is actually common for denim, raw fabric, raw washed and desized which is only desized which Marter sample number 1. Sample number 2 is enzyme washed for 60 minutes sample number 3 is enzyme washed and heavy bleached then washed and enzyme bleached and tint wash enzyme tint wash enzyme iced wash enzyme ball washed stone wash for 75 minutes enzyme and slight bleach wash.

So, these are the different type of wash fabric, and what we have got this fabrics we have again actually tested subjectively by large number of actually evaluator here we have taken a large number of evaluators.

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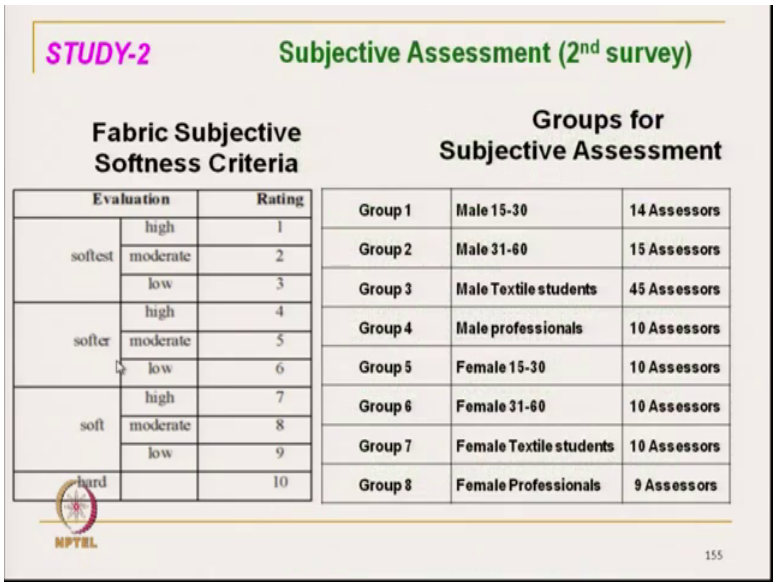

The evaluators are of different group eight different groups of evaluator and total we will have.

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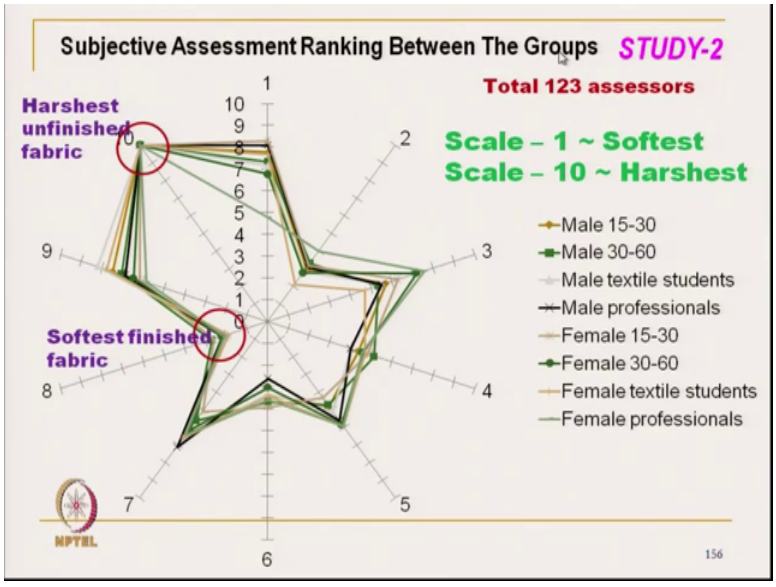

Total you have more than 100 evaluators 123 evaluator's assessors. So, this total 123 assessors they have been trained for the softness value and here our idea was to evaluate

the fabric in 10 different scales, 10 different scales what we have got the softest high moderate low.

So, if you feel the fabric is very soft, then also you rate the fabrics in high moderate and low. Similarly its medium soft it is a high moderate low soft high moderate low and hard if it is very hard you cannot place anywhere that. So, the evaluators they have not been actually disclosed the type of fabric ok, they have been only asked to give us the overall softness value. And this is the rating scales have been developed and the evaluators are of different background of different age group ok.

So and total 123 evaluators have been taken here; so, scale 1 which we know it is a softest fabric and scale 10 it is a hardest fabric is the ok. And what we have got here, it is a this fabric, it is a it is almost 10 which is hardest fabric which is basically ultimately which is not being washed fabric and fabric softest fabric is this one.

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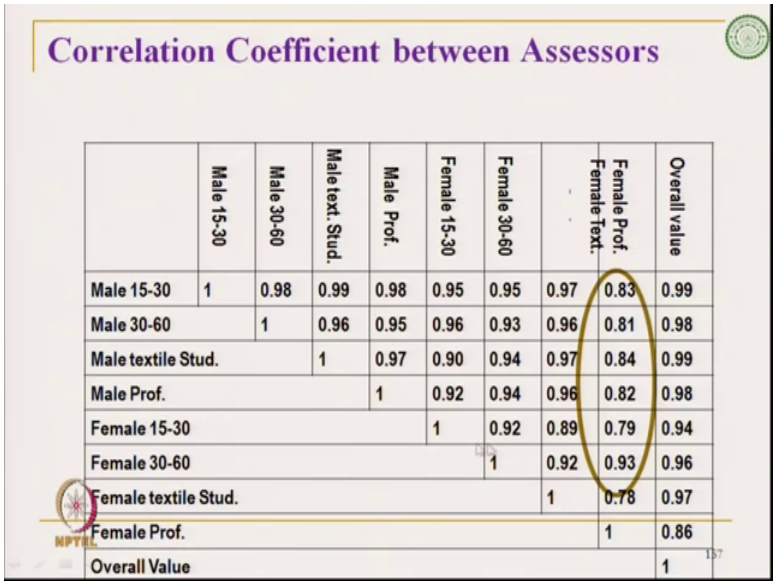

And we have also measured the correlation between the different among the different evaluators.

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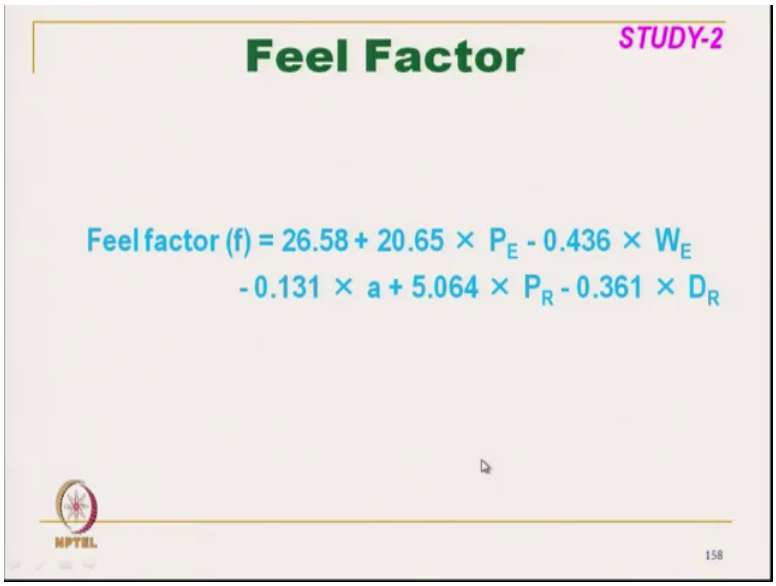

And this evaluation the softness evaluation fabric feel evaluation is its subjective evaluation and same fabrics we have tested by the instrument, and we have got different the different curves and from there as we have mentioned the P E W E this P R D R. These are the parameters which we have got from the extraction curve nozzle extraction curve, that is a and radial force and energy and work done.

So, all from this curve through the statistical analysis, we have got the, this is the equation which gives the fabric feel factor and this is this values we have got by the curve fitting.

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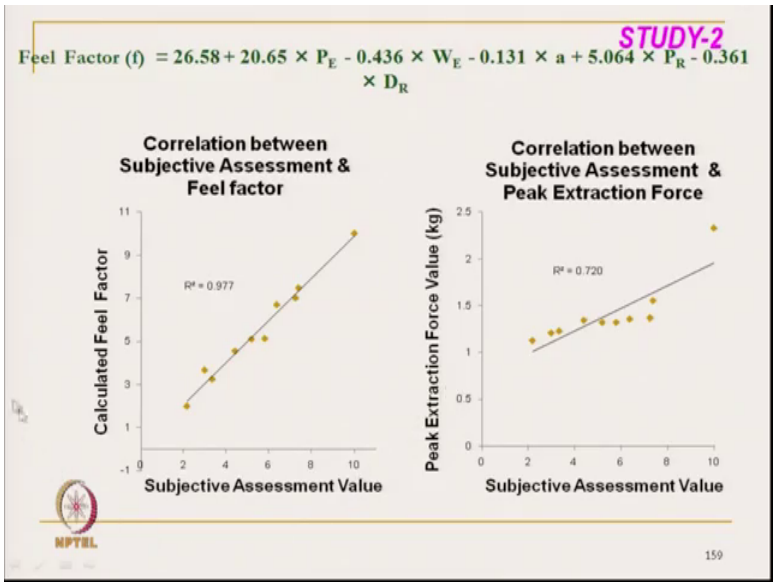

And this fabric feel factor the values have been selected in such a fashion that it is actually scaled in such a fashion the feel factors the range is between 1 to 10. So, that we can in our subjective assessment, we have got the value of subjective assessment from 1 to 10, the feel factor also has been actually converted in terms of 1 to 10. So, 10 means hards value and 1 means it is softest value and we have seen this correlation between subjective assessment and fabric feel factor, this is the fabric. It is a very good correlation we have observed and this subjective and assessment of fabric feel.

And so, from here we can we can claim that this instrument. It gives very good subjective assessment. It is a very good actually indication of the actual fabric feel in use and where we have got the correlation coefficient is close to 1 basically its perfect 0.977 is the correlation coefficient we have got. But this fabric feel factor it is a we have to analyze we have get the from the total curves. So, the software is there. So, after just after testing a particular and if you feed this fabric feel factor this value equation the automatically the software will give us the fabric feel factor this equation is developed for the denim fabric of that particular range. Now then we thought that let us try to correlate with the subjective assessment value with the peak extraction force.

But which we have got it is a correlation coefficient is we have received it is a much more. Although it gives certain indication, but it does not actually gives the; it correlate well with the subjective. So, our recommendation is that it is a ultimately we have to

analyze the total curve, then we can get the total fabric feel factor and this feel factor is correlated with the subjective assessment.

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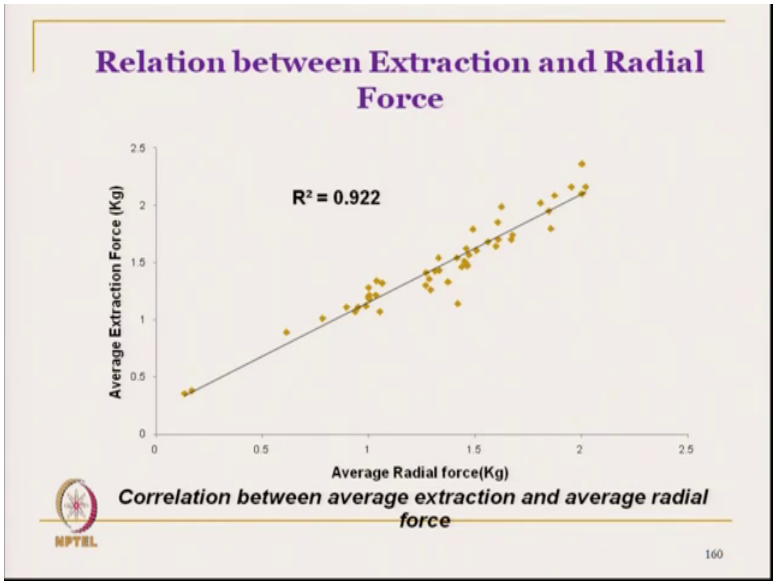

Then what we have tried, we have tried it is the average radial force and average extraction force that we have tried to correlate. So, this correlation is close to 0.99. So, the idea is here. So, whether do we need the radial force measurement?

So, although it gives the idea about the extraction force average extraction force gives clear idea about the radial force also. So, we can make the instrument much simpler to have only extraction force and also the equation much simpler to give the get the value of the subjective assessment.

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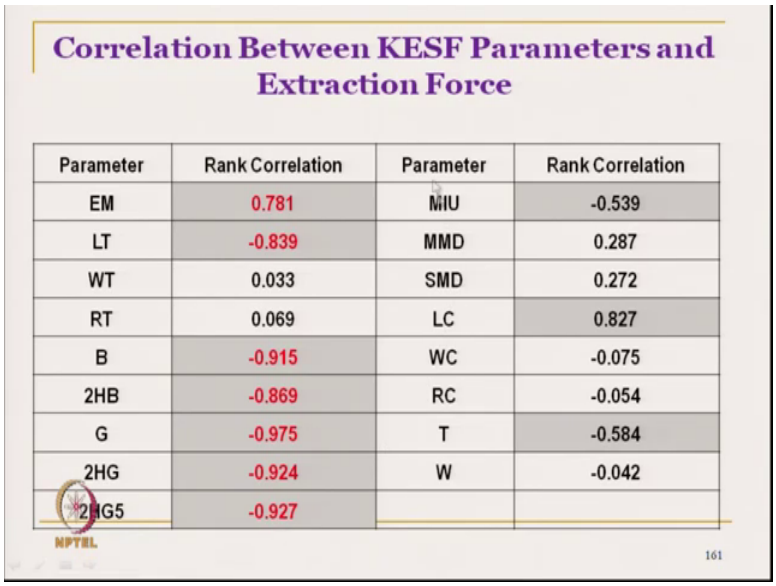

Then we have tried to correlate this extraction force; extraction force with the different parameters we have which we can received from the KSH instruments. So, ultimately finally, what we have observed we have concluded this basically there is no such proper correlation between the extraction force or this each of the other parameters individual parameters.

So, that we can conclude that the extraction through extraction value the whatever extraction force we are getting its a complex combination of all this. It is not the with the individual value, we cannot compare with the any of the individual values, but it gives the complex combination of different parameters and ultimately, it gives unique value which we have actually seen. It is very well correlated with the subjective assessment of the fabric. So, now, we will discuss the various this parameters, how this parameters are actually reflecting the actual fabric we will give some.

So, now we will take some example of an actual fabrics the fabrics feel fabric tactile sensation and how this parameters are related.

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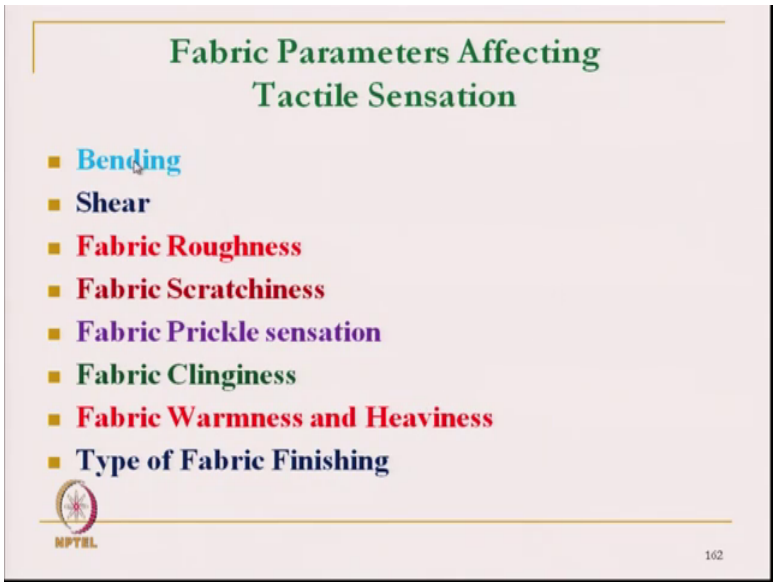

So, fabric parameters effecting the tactile sensations are bending shear, fabric roughness scratchiness, fabric prickle sensations, fabric clinginess and fabric warm and warmness and heaviness. So, all these sensations, now we will discuss and how the fabric fiber and fiber yarn and fabric parameters effect all this sensations bending related sensation, shear related sensation, fabric roughness related sensation. All this sensation are related with the fiber characteristics, yarn characteristics and fabric characteristics these things we will discuss now ok.

So, bending and shear all this characteristic, we can directly related with the KSH value fabric hand value and type of fabric finishes. So, these things we will discuss one by one.

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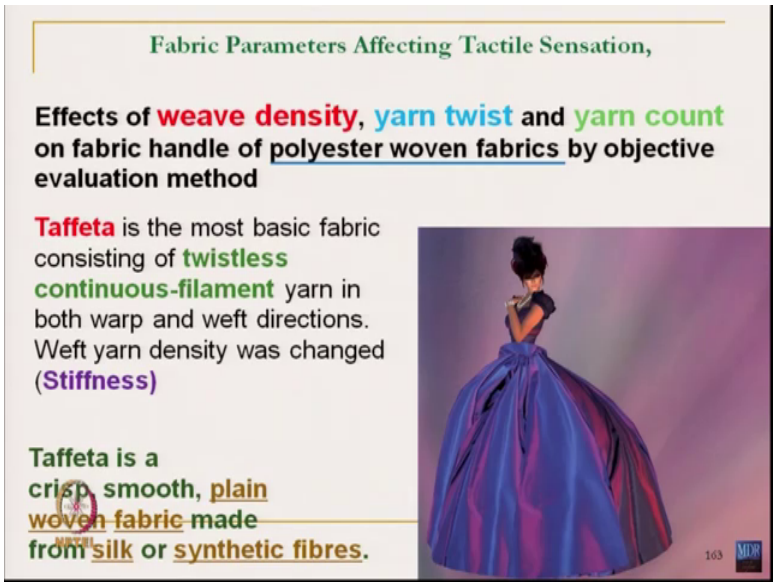

And the fabric parameters actually which are which effect the , which is effected by the type of yarn used, type of structure type of number of yarns per inch and pix per inch and ultimately it gives the sensation tactile sensation. Now here now we will discuss the one study which actually shows the effect of weave density the ends per inch and pix per inch, the amount of twist the changing twist and yarn count how all this parameters effect the fabric tactile sensation like as we I am we have mentioned here. These are the tactile sensation roughness and all these clinginess.

So, here in this study; polyester fabric sub in taken polyester oven fabric. So, polyester it is not the staple fiber. It is a polyester filament oven fabric of different weave density, different twist structure, different yarn count has been taken and it is tested by objective evaluation using first using its Kawata system, then we will discuss various studies. So, one of the very commonly used fabric for a dress material it is a taffeta what is taffeta? It is a most basic fabric which consist of twist less continuous filament in both warp and weft direction where weft yarn density was changed.

So, this is the fabric made up. So, this is the taffeta the fabric with the picture which is from the loop, we can make it is a shiny, because of the it is a twist less twist less filament made a polyester filament both warp and weft direction ok. So, effect of twist is not here its twist less. So, weave density is changed because it is a weft yarn densities changed. So, weft yarn number of pix per inch has been changed here. So, taffeta is a it is

a crisp smooth plane oven fabric made up silk. Normally it is made up silk or synthetic fiber here this; fabric is made of synthetic fiber ok.

So, this fabric is actually characterized in terms of its a crispy fabric it is a smooth, but crispy fabric why is it crispy? It is a made of filament twist less filament crispiness means it gives some sticks lift measurement smooth fabric it is a twist less smooth fabric plane oven fabric. So, this is the type of it is a nature of this fabric and here the variability is that, we have changed the, it has been the weft density it is from open structure to compact structure. So, it is a taffeta.

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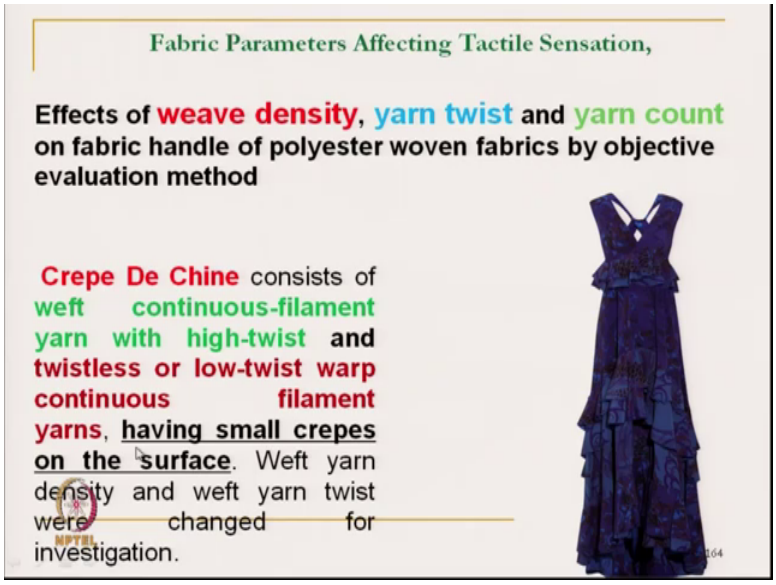

Next fabric is that again it is a Crepe De Chine; it consists of weft yarn of continuous filament with high twist. So, earlier we have seen both the yarns were twist less here warp yarn is a low twisted here. It may be twist less or continues filament or very low twisted here. So, we can use normally twist less here warp and weft yarn a continuous filament with very high twisted. So, due to this high twist it creates little bit crepe.

So, crepe de chine; so, it has small crepe on the surface. So, this small crepe on the surface due to high twist in the weft, it gives certain feeling. So, we can just imagine the fabric earlier when there is no twist and the fabric with weft yarn of different twist high twist, will give different feeling different tactile sensation the weft yarn density and weft yarn twist are changed. Here the density of weft yarn that is the weft number of weft yarn per unit length is changed.

So, per weft yarn density and twist in weft yarn is also changed. So, this is the weft variable here. So, weft yarn density and weft yarn twist is changed here ok.

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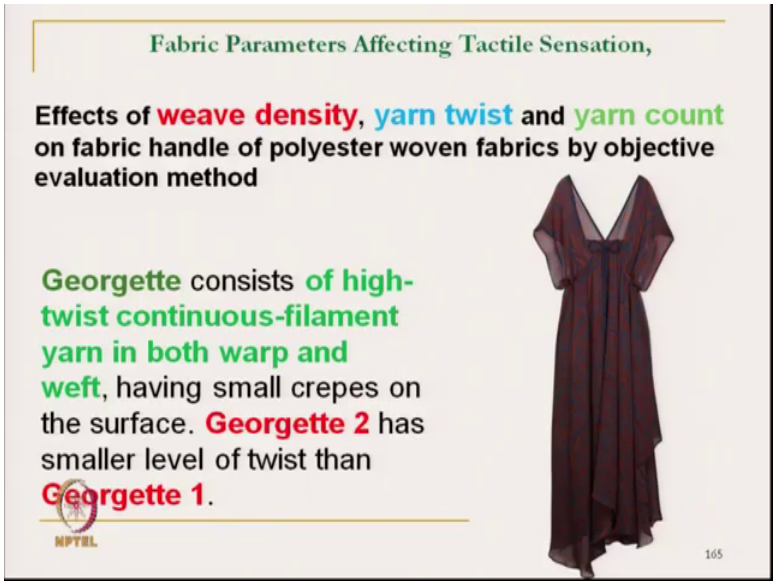

So, the next category of fabric is used here, it is georgette. It is a very commonly used fabric, where it consist of high twisted yarn in both warp and weft made up continuous filament. So, again due to twist in both high twisted yarn in both warp and weft, the feeling of the fabric the tactile sensation of the fabric will be different from that of chepe de chine. So, it has got two types of georgettes have been used it is a smaller level and higher level of georgette one and georgette 2. So, there are other fabrics. So, other; so, we will discuss in the next class so.

Thank you.