Evaluation of Textile Materials
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Lecture-38
Evaluation of Pilling and Abrasion Properties of Fabrics

Hello everyone, so our today's topic of discussion is pilling testing and abrasion testing.

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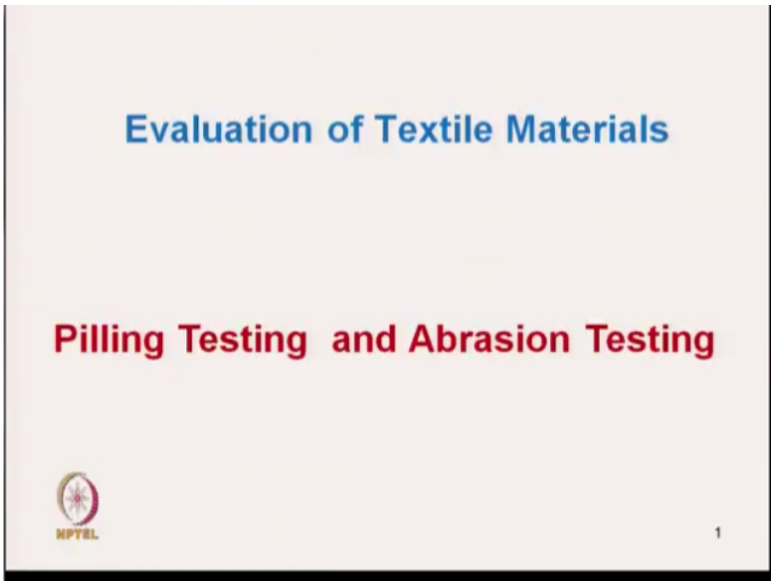

This 2 parameters are extremely important as per as fabric use is concern and pilling is very important mainly for apparel type of fabric apparel use and abrasion is both for apparel and the industrial application. So, pilling is related with the actually the look of the fabric, the appearance of the fabric ok first we will discuss the all the specs related to pilling and after pilling then we will start the abrasion although this abrasion and pilling there interlinked.

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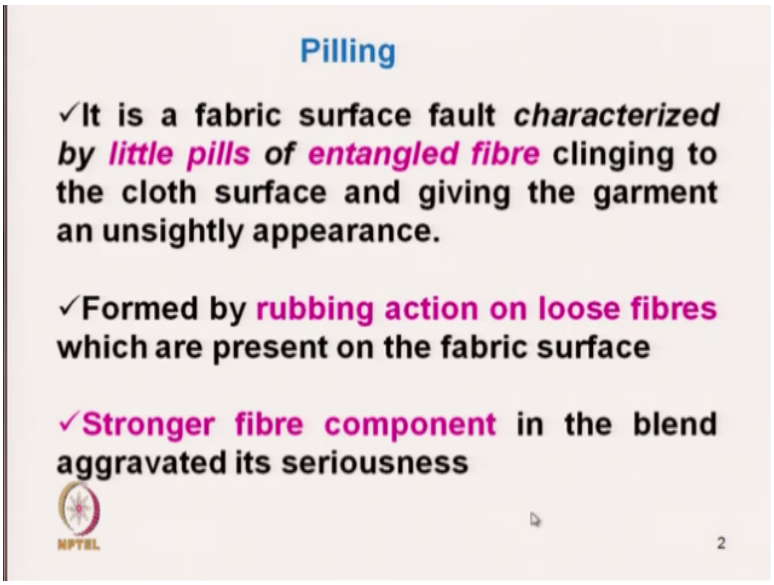

So, what is pilling, it is a fabric surface fault ok characterized by little pills of entangled fibres clinging to the cloth surface and which is giving garment unsightly appearance. So, it is a ugly appearance it gives, so we must actually emphasize the term it is a little pills and entangled fibres. So, fibres are actually the pilling starts with the fibre entanglement ok and formed by rubbing action on loose fibres which are present on the fabric surface, now let us 1st try to understand the concept of pilling.

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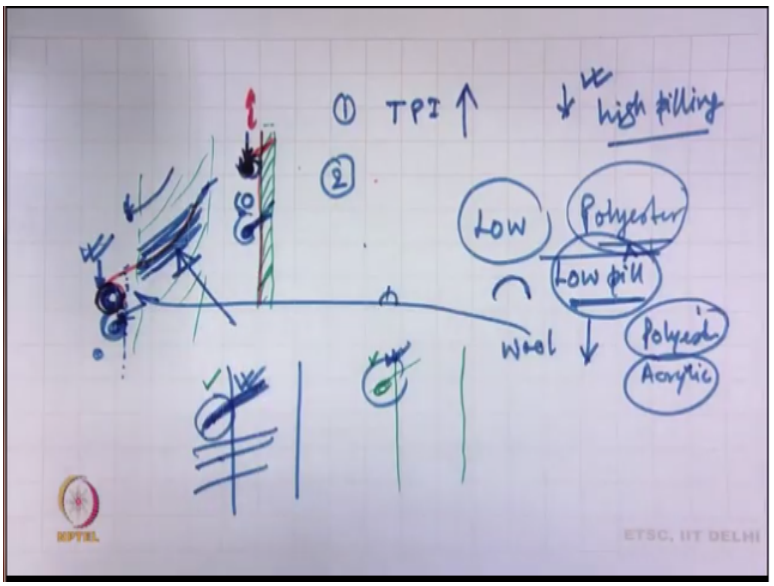

This is one fabric surface ok it has say yarns, so this is a fabric with the made of surface yarn ok. Now the pill suppose 1 small hair is projected here 1 hair is projected here and due to the rubbing action of fabric surface, this side is a surface and there will be some rolling of the fibre, it will

form a small pill small which may not be visible, now due to the rubbing action with other surface it wills say it will apply certain force on this fibre.

And this force will have will create some rolling action of the this ball formation, this end at this end will suppose the force is acting on the on this tangentially on this surface. So, there will be 1 rolling action of this ball along the surface this along this surface there is a rolling action, so this rolling action will create the other end. Suppose this is a and this is the other end of fibre and when this force is and this is the fabric surface when this force is applied here, the rubbing force.

There will be 1 torque generated here which will actually result which will try to pool this other end fibre, fibre from other end. Once the this yarn this other end fibre which is actually inside a yarn, this is yarn. This yarn if the yarn is loose twisted loose structure then this fibre will have easy way easy path to come out and join with this rolling action. That means very small roll initially is created and due to the repeated rubbing action.

This is actually rolling and rolling and then this yarn and the other end from the other end fibres are coming out and the pills are becoming yarns are enlarged. And this is the mechanism of pilling and that is resulted by many factors 1st is that 1 is that if the yarn structure is loose then it is allowing the fibre to come out and form pill. So, what we can do we can increase the twist we can make the yarn compact then what will happen.

This will if the if yarn is very compact this will not allow the fibre to come out smooth easily that means 1 yarn say 2 yarn 2 fabrics, 1 fabric is made of yarn with high twist. Another is made of low twist, so yarn made of with low twist will have high pilling resistance pilling tendency. So, that means if we have yarn if we have fabric made of a loose twisted low twisted yarn that will create high actual level of pills.

So, that normally in winter cloth we have seen which actually resulted high pilling due to the loosed structure of yarn. Second this is the twist second suppose we have 2 yarns made of 2 different fibre 1 is suppose this is the 2 yarns this yarn is made of coarse fibre coarser fibre.

Another yarn which is made of fine yarn fine fibre same very fine fibre, now the thing is that the flexural rigidity of this fibre is much less than this one coarser one.

So, this fibre will have tendency to form to bend and form loop it will easily get rolled but this fibre will not roll easily. That means if it does not roll that means this phenomena will not take place, so here as it is not forming the ball although this will create hairs ok. But the fibre with lower bending rigidity will create the pills that is why in a cotton if there is immature cotton that will result the pilling tendency ok.

So, we can use 2 fibres 1 is coarse fibre fabric made of coarse fibre will actually have less pilling tendency then the fabric made of fine fabric that is due to the bending rigidity of the fibre ok. This is the reason another case we must have observed that the fabric made of pure wool 100% wool has less tendency of pilling. Then the fabric made of wool blended or maybe 100% acrylic, so the reason is behind is that the wool has got less bending strength.

That is lateral strength of wool is less than say polyester or acrylic, so what is lateral strength that means it is a wool is little bit brittle in nature. So, if it bends wool breaks, lateral strength but for synthetic fibres the lateral strength is very high, so the problem is that in wool in case of wool once it is folding, suppose it is somehow it is folding. In the initial stage due to less bending strength ok lateral strength, this will actually break.

And get separated from the structure although pill formation maybe there it has already initiated but this even at the initial state due to the rubbing action this will actually form and still it will break and it will get separated from the starch surface. So, the fabric will look little bit cleaner but once we use polyester or say acrylic blended with wool what will happen whatever the things we are forming formation is there.

Even if it is the formation by wool the blend the acrylic portion of the fibre or polyester portion of the fibre will actually try to hold this pill. Because of the high strength or high bending or high lateral strength this fibre or even tensile strength it has got high extensibility and high tensile

strength. So, polyester will try to hold back the pills and it will actually stick to the surface of the fabric.

So, once we blend wool with the synthetic fibre or we use 100% synthetic fibre it actually create the pills. So, pill formation there are various result, so 1 is the twist low twisted fabric will have higher pilling tendency fabric made of finer fibre will have higher pilling tendency. And fabric made of high strength fibre will have higher pilling tendency, now there are some manmade fibres which have been develop with low breaking strength, low lateral strength.

Lower lateral strength and this like polyester during polyester manufacturing what has been done the molecular structure has distorted they changed in such a fashion. The lateral strength of the fabric is reduced, lateral strength of the fibre has been reduced, the fibre has been made little bit brittle. So, that this type of polyester fibre is called low pill polyester, so it is available in market as low pill polyester.

So, if we make fabric polyester made of polyester blend or prepare fabric from this type of fibre the tendency of pilling will be less. Because as the pill formation is initiated this will immediately break and it will get separated that is why what we have observe that cotton 100% cotton pilling tendency is not that high. If we prepare a cotton cloth with high twist relatively high twist, so pilling tendency will be can be controlled.

But with the low twisted fabric yarn the pilling tendency will be high ok, so it is formed by rubbing action on loose fibre which are present on the fabric surface. Stronger fibre component in the blend aggravate it is seriousness ok.

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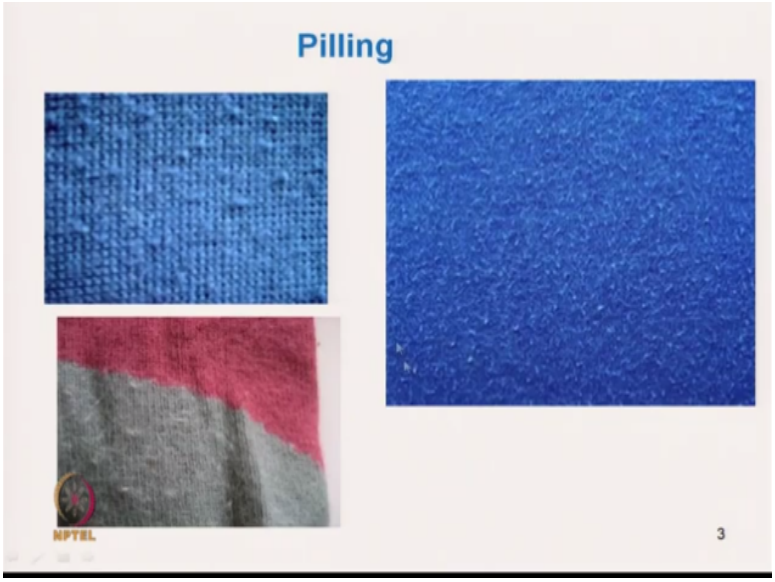

So, these are the pills which are it is visible in the on the surface which attached with the fabric ok.

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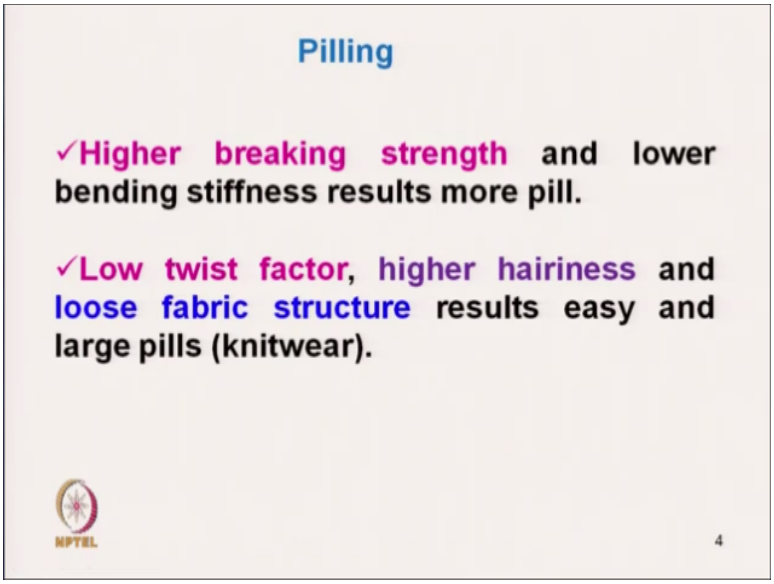

So, higher breaking strength and lower bending stiffness results more pill as I have mentioned lower bending stiffness comes from say maybe finer fibre ok. So, that will and higher bending breaking strength. Low twist factor high hairiness definitely pilling is initiated from higher hairiness and loose fabric structure result easy and larger pills say like knitwear made of loose low twist factor yarn.

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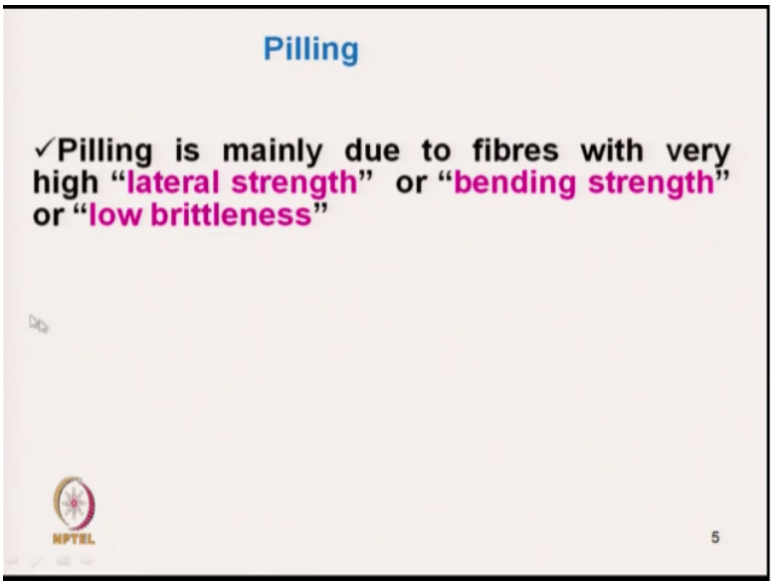

Pilling is mainly due to the fibres with very high lateral strength as I have just mention or bending strength or low brittleness. So, if we increase the brittleness then we can improve the pilling actually pilling behavior improve it, so pilling tendency will be reduced. So, the high lateral strength maybe advantageous in some application like technical textiles or floor covering but for pill as per as pilling tendency is concern the pilling tendency actually increases.

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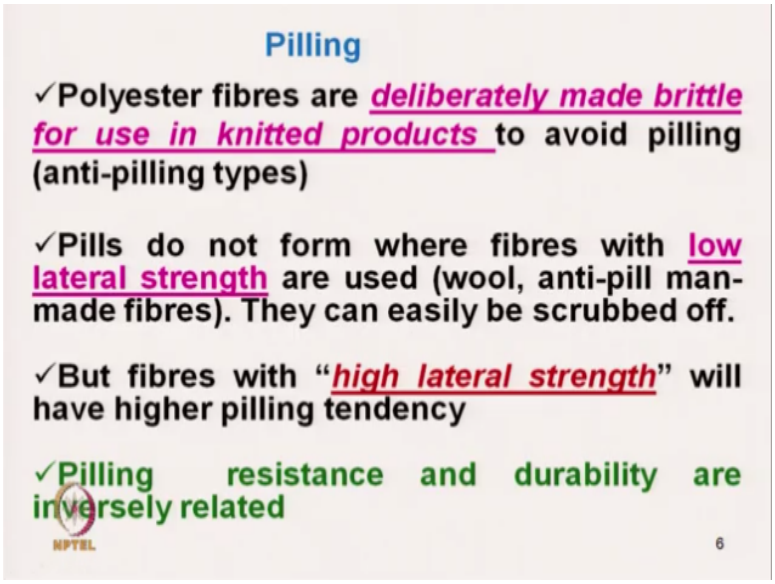

So, in apparel sector low lateral strength is preferable particularly knitted**,** so the as I have mentioned the low pill polyester is available, polyester fibres are deliberately made brittle for use in knitted product ok to avoid pilling. So, for knitting industry low pill polyester is actually now

a days used it is called anti pilling type. Pills do not form where fibres with low lateral strength is there like wool, anti-pill manmade fibres ok, they can be easily scrubbed off.

So, pilling if pilling still forms, so they can be easily removed but fibres with high lateral strength will have higher pilling tendency they will try to actually hold the pilling back on the surface of fabric. And pilling resistance and durability are inversely related that means if we want durability in the fabric then pilling resistance will be low. So, that means that will form pilling due to the high lateral strength.

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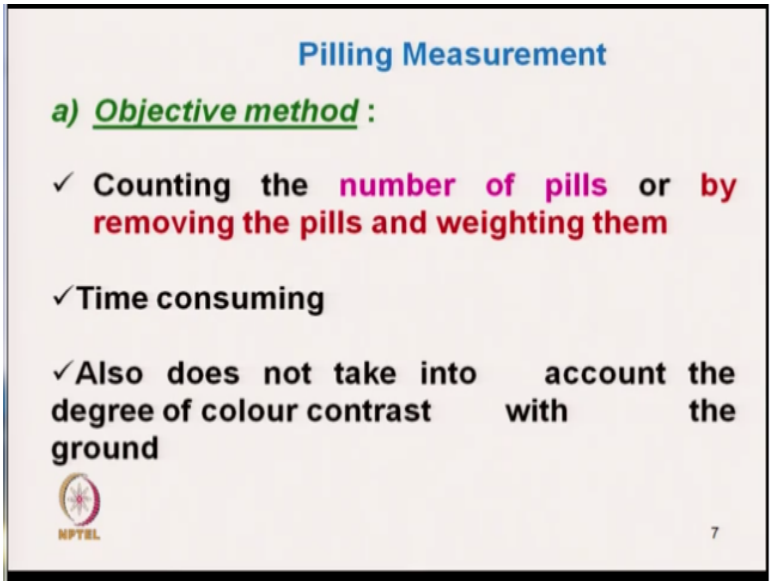

Now as per as measurement is concern there are 2 types of measurement one is objective measurement which we can actually take the value get the actual numerical value another is subjective measurement like objective measurement is that. So, in the on the surface we can simply count the number of pills and we can convert say per square meter number of **pill** pills we can just count or we can remove the pills and take the mass.

So, in this 2 ways we can express the pilling but the main problem of this method are the it is time consuming and it also does not take care of actual degree of color which is very important. Suppose a dark shade will black color cloth with black smaller pills will be maybe acceptable but if color contrast is there that severity we cannot actually judge by measuring the number of pills or mass of pills.

So, if we actually if 2 fabrics with same number of pills in 1 of the fabrics maybe it may be totally objectionable because of the color contrast. So, it does not take color contrast, so and due to the fact it takes it is a very time consuming, so this type of method. This method is not in use it is not popular, so subjective measure method is popular.

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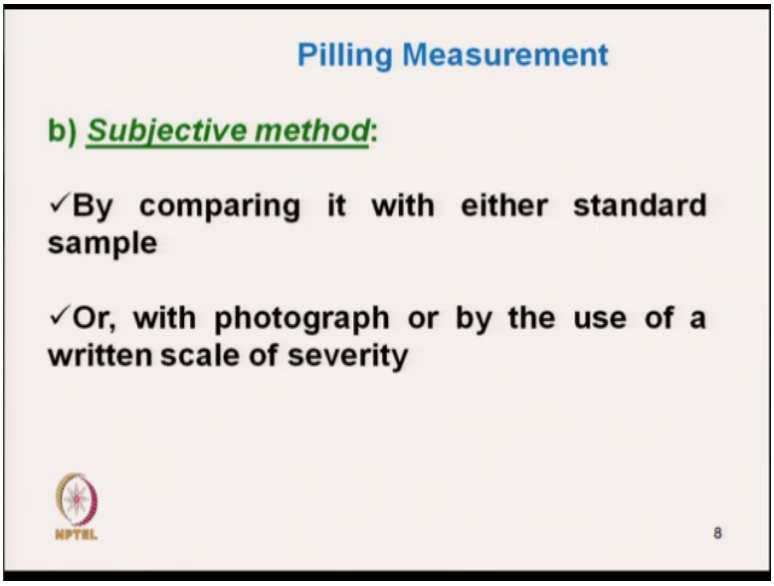

And it is it takes it does not take manual work too much it is a it does not take that much time although the some of the test may take longer time but the instrument can be started and no monitoring is required during the process. So, by comparing with the with either the standard sample or with the photograph or by use of any written scale we can take we can actually compare the severity of the pilling ok, that is a subjective, now there are standard grades ok.

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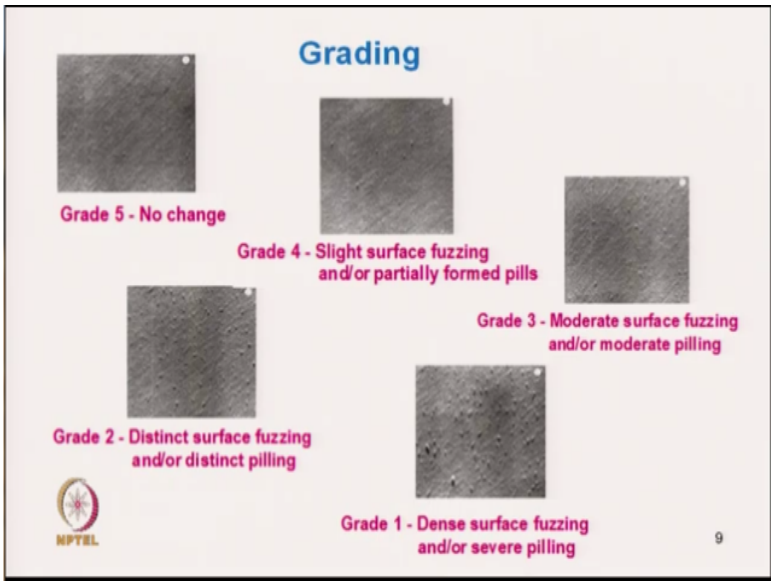

So, grading starts from say 5 the 5 grade 1 to 5, 5 means there is no change after rubbing there is no change, no pill formation, grade 4 it is slight actually surface fuzziness ok small pilling partially it is formed there is grad 4, grade 3 is moderate surface grade 4, 5 grade 2 is the distinct lead there will be zinc formation. And grade 5 is actually rejected it is a severe pilling is there, so in this way it is a standard we can compare with the standard photograph and grade the fabric after certain cycle of rubbing.

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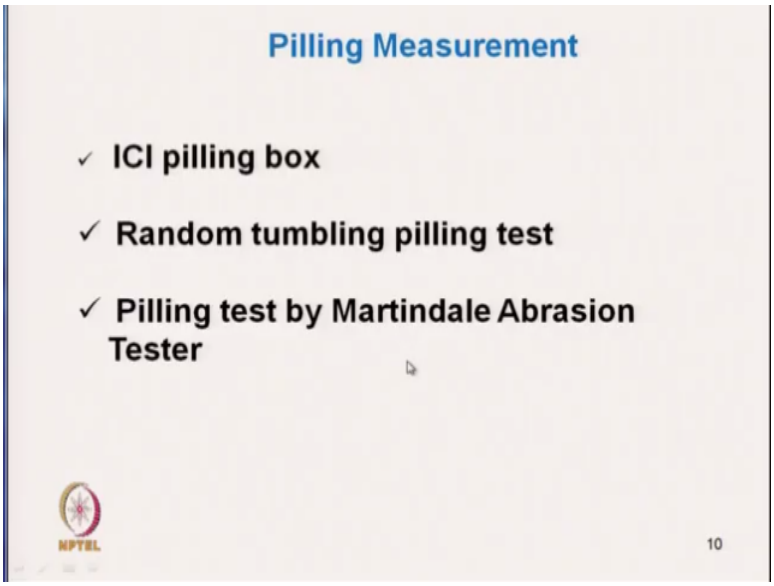

So, there are methods one is the ICI pilling box then random tumbling pilling test and another instrument which is actually used a Martindale Abrasion tester. This abrasion tester it is used for

abrasion as well as pilling ok in the same method we can actually judge the fabric for pilling performance. So, in ICI pilling box it is a simple there are 2 boxes with cork lining ok.

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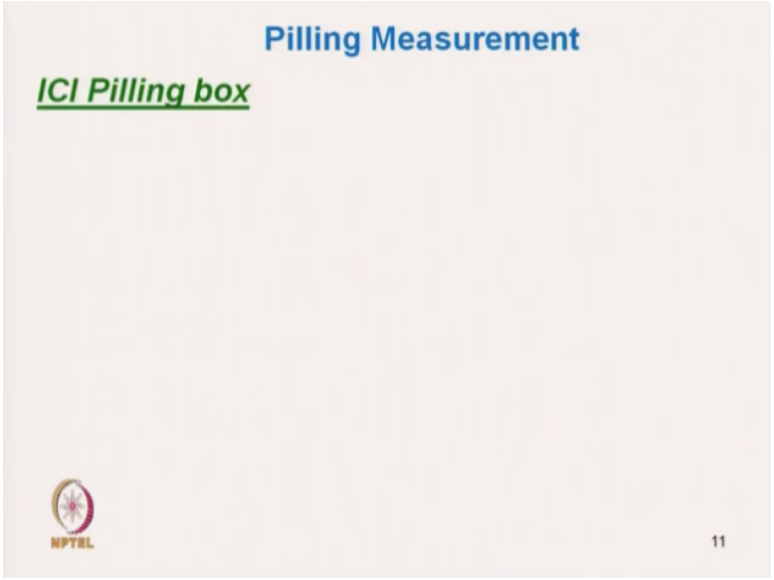

So, this is the 4 specimens are placed with the size actually that this specimens are cut with size 125 millimeter above 125 millimeter square. And then it is a form the 2 for warp and 2 for weft and stitched the face to face and then turned inside out. So, that face comes out ok and then fabric the roll the it is become a tubular and it is inserted through a tube rubber tube, the loose ends are ends tapped with the PVC tape.

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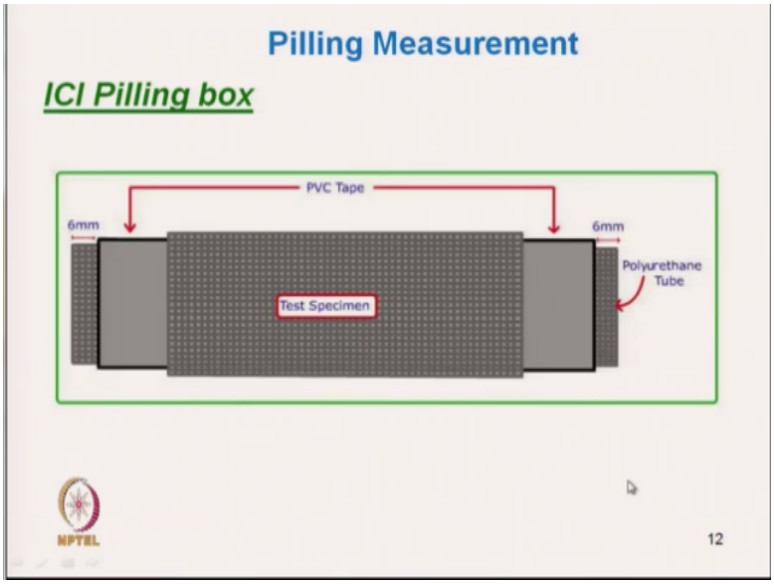

Like this, this is a fabric sample and here is a PVC tape and this type of the loose ends are actually sealed with a PVC tape.

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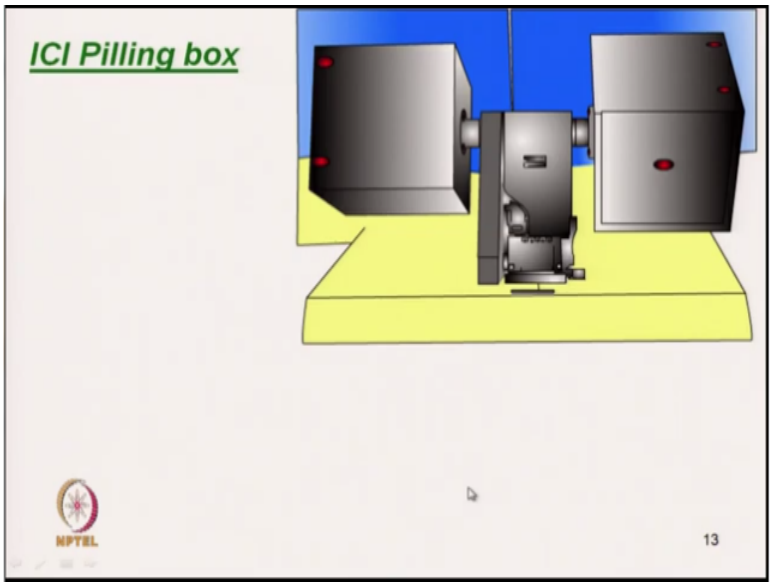

And these are placed on this ICI pilling box where all 4 samples are taken the tumbled together in a cork lined box ok this is a cork lined box and allowed for certain revolution of time. So, it is actually takes certain number of revolution, so that is how this instrument goes. So, we can allow it to rotate for certain time.

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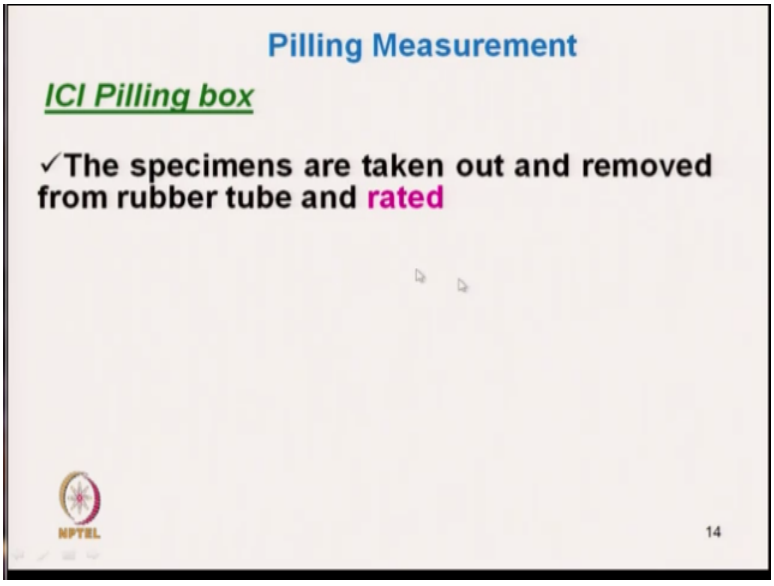

And the specimens are then taken out and removed from rubber tube and then rated. So, rubber tubes then after taking out this specimen then rubber tubes are taken then stitched are removed and flattened fabric sample is rated with the using by using the standard photograph ok.

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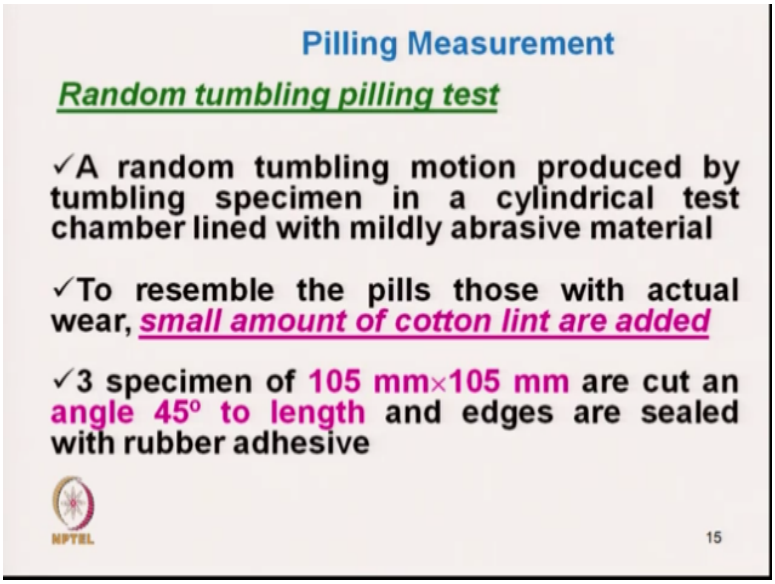

Next is that random tumbling pilling test, so this is actually there will be a random tumbling motion is produced which is actually simulating the our normal washing machine or normal application ok produced by tumbling the specimen in a cylindrical test chamber lined with mild abrasive material some cork type some mild abrasive material is there, so that it will actually the sample will be rubbed against that this liner lining along with some actually lined cotton lint.

It just to simulate the pilling in actual application ok to resemble the pilling to those in actual wear small amount of cotton lints are added in the tumbling tester. 3 specimens of 105 by 105 millimeter are cut at an angle of 45 degree with a warp side ok and the edges are sealed with the rubber adhesive, so, that the threads are not coming out ok.

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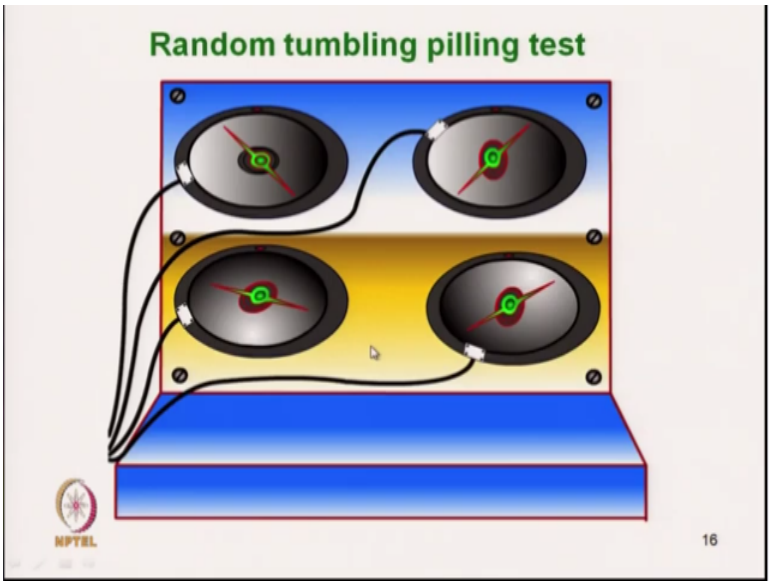

And this is these are the random tumbler.

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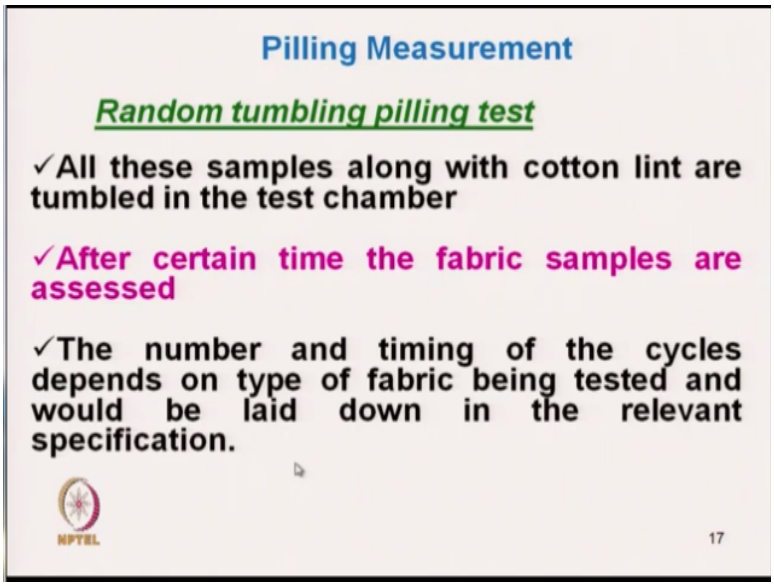

And after that all these samples along with the cotton lints are tumbled in the test chamber after certain time the fabric samples are assessed ok. The number and the timing of the cycles depend on the type of fabric being tested and would be laid down in the relevant specimen. So, for different types of fabric or number of cycles or timing are different say so for compact type fabric we may require. Higher tumbling cycle for loose fabric or knitted fabric we may require less number of tumbling cycle.

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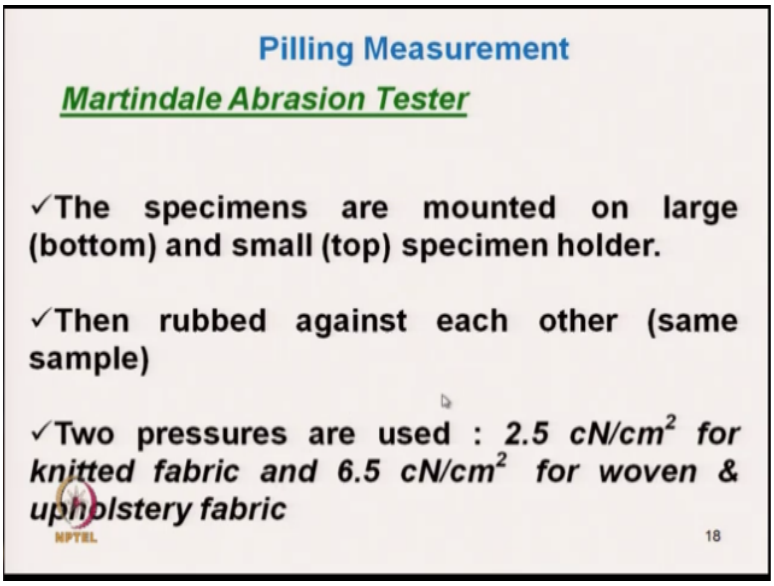

Another method is that it is Martindale abrasion tester where the specimens are mounted on a large bottom and small top specimen holder. Here the thing is that in Martindale abrasion tester where we use 1 abradent standard abradent sample in the bottom normally ok. But here in that small modification is there here the both bottom and top specimen holder the same fabrics are tested, so same fabric specimens are tested and they are actually rubbed against each other.

So, same fabric test fabrics are there they rubbed against each other this same sample and 2 pressures are used 2.5 Newton/centimeter and another is for knitted fabric we require low pressure. And for woven fabric we require higher pressure because knitted fabrics are loose in structure ok.

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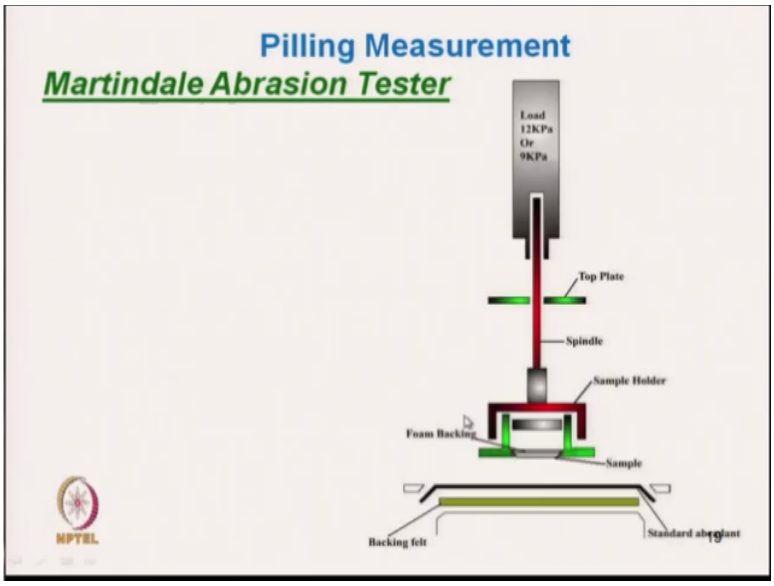

These are the specimens this is the sample another fabric is here.

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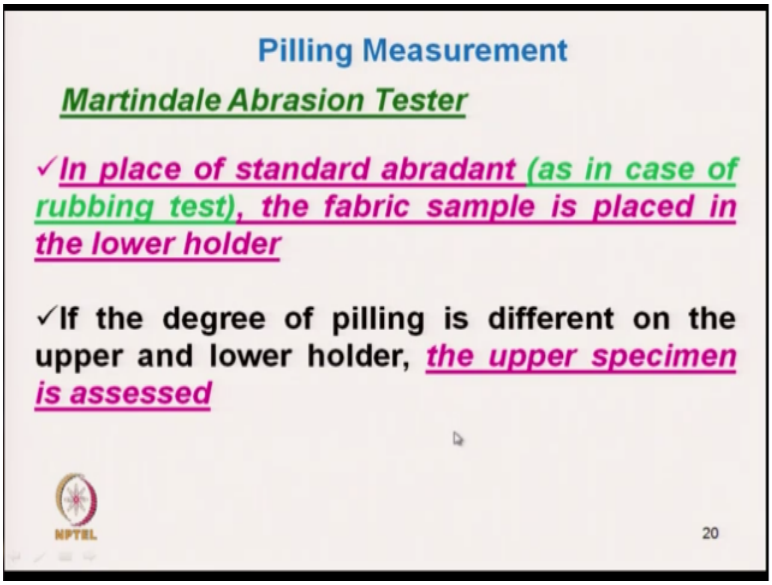

They are rubbing in each other and in **in** place of standard abradant as in case of rubber rubbing test as I have mentioned the fabric specimen is placed in lower holder. In rubbing test we will see the standard abradants are used. Now the same fabrics are tested, so ideally there should be the pilling should be same for both the fabrics if the degree of pilling is different in upper and lower. In that case only the upper specimen is assessed not the lower specimen otherwise we can assess any of these 2.

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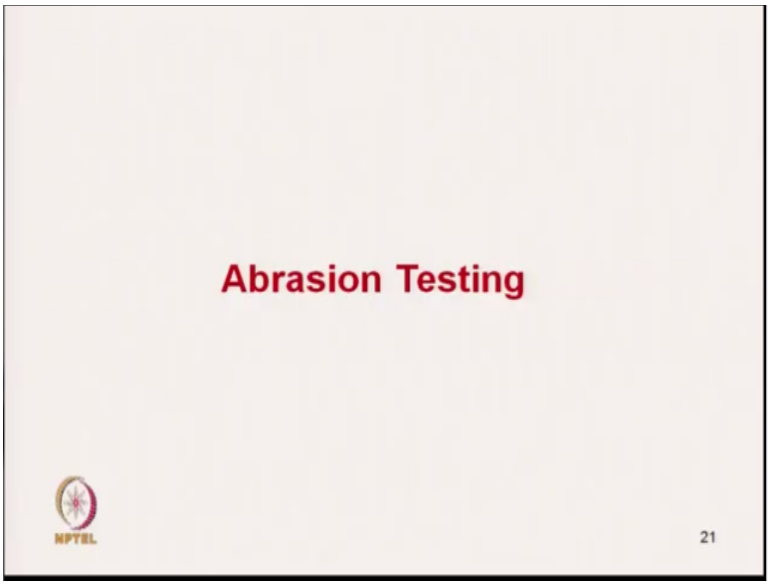

Now our next part is that it is a abrasion testing.

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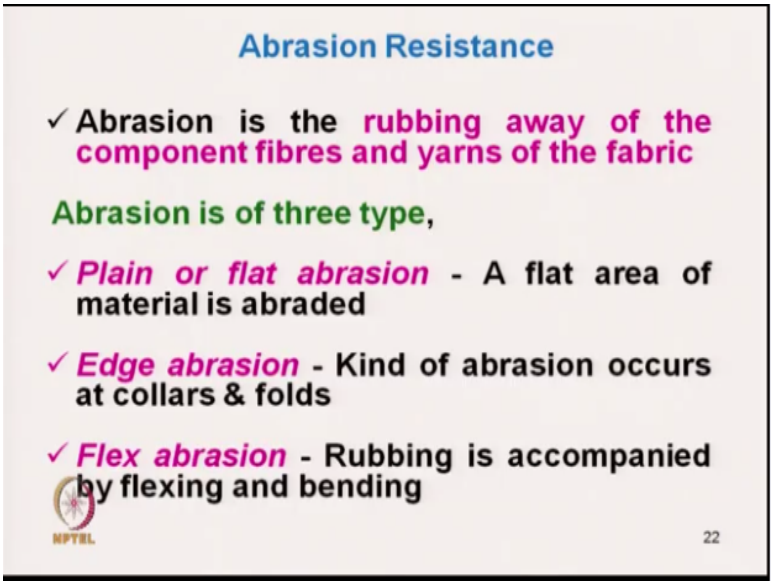

Now abrasion is the rubbing away of the component fibres or yarn, so it actually when we the fibres come out from the surface and ultimately the yarn breaks. So, the rubbing away of the fibres and yarns of the fabrics ok, so that during abrasion it comes out, so, abrasion there are 3 types of abrasion one is flat abrasion.

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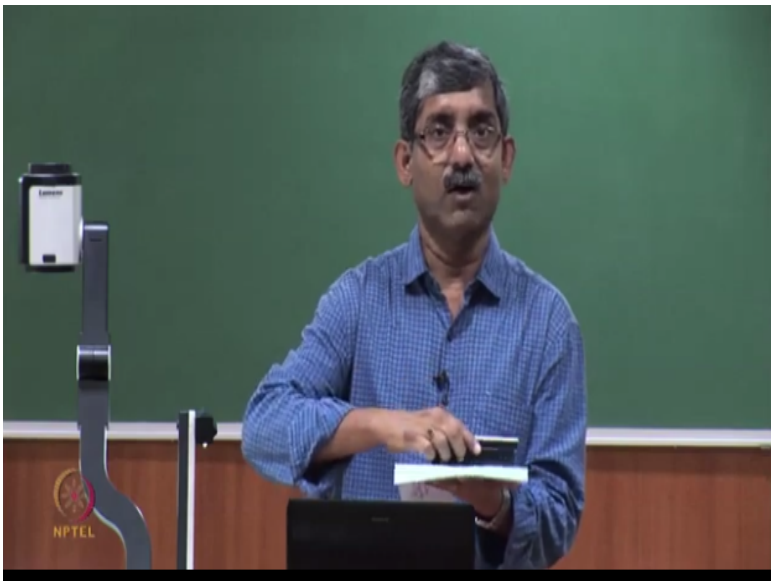

Like if we take this fabric this is a fabric and we are abrading with certain abradant this is called flat abrasion ok. Another is called it is a flex abrasion the plain this is plain or flat abrasion another is edge abrasion.

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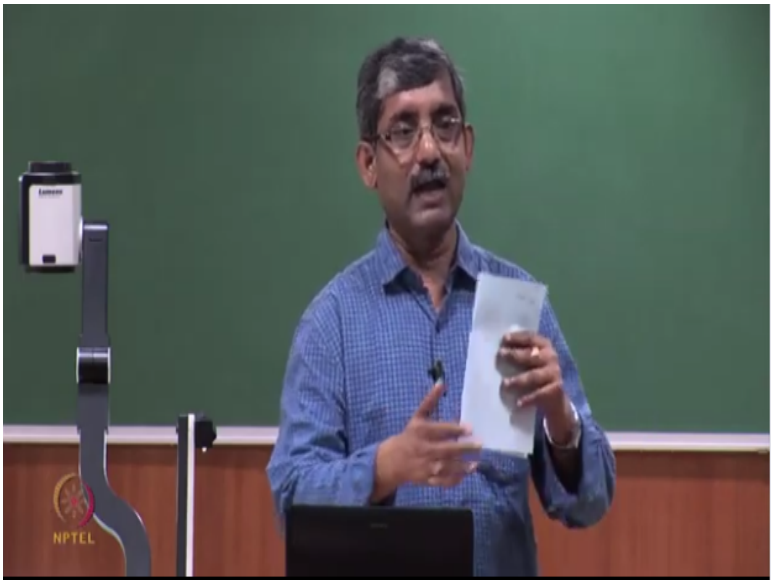

So, like the we form 1 edge of the fabric and then we abret we can abret, so kind of abrasion we can see normally in a in the collar or cuff or any fold, this type of abrasion takes place. This simulates this type of situation, so it has been observe that plain abrasion the abrasive abrasion strength is very high. But at age abrasion as the age the surface area is small, so the effective pressure on that fabric is high.

So, that means at the age the abrasion strength is much lower, so the fabric the abret very quickly at the age of the fabric. Another is flex abrasions, so it is by flexing and blending like so this is the fabric.

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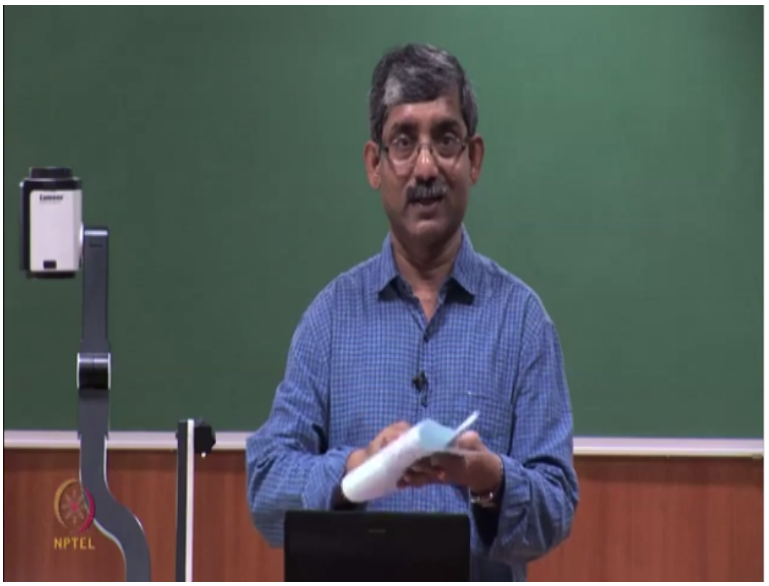

And this is abraded in this fashion by bending and flexing so when the abrasion is in this type of abrasion is there it is called it has actually abrasion along with the flexing or blending ok. Now there are different factors which affect the abrasion ok 1st factor is the fibre type.

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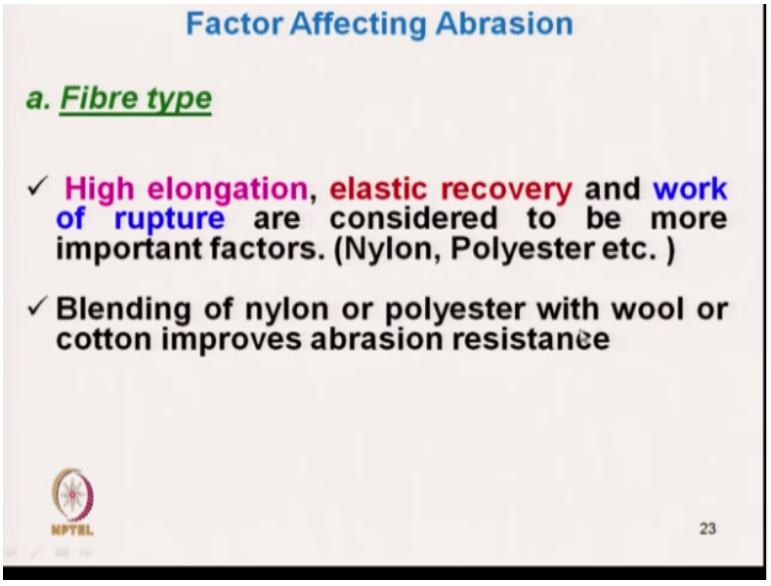

Now a fibre a strong fibre with higher elasticity will have higher strength higher breaking energy higher work of rupture will have higher abrasion test ok. So, high elongation, high elastic

recovery, higher work of rupture are consider to be more important factors ok. Now poly nylon, so it is very common experience the nylon socks are actually popular it is basically due to the fact nylon has got very high elastic recovery high elongation and high work of rupture.

So, fabric with made of high fibre with high work of rupture that means once it is during rubbing when force is applied the fibre will get extended but it will not break. And at the same time due to higher elastic recovery it will come back to it is original position ok. So, that is how the fibre with high breaking elongation, so strong fibre and brittle in nature will immediately actually fail.

Because during abrasion the fibre has to actually absorb some energy, so higher work of rupture will have higher abrasion strength. Then blending, so blending of nylon or polyester with wool or cotton improve the abrasion resistance. So, wool if we use 100% wool in socks the due to abrasion with a shoe or with the skin mainly with the shoe it will immediately form holes but if we blend the wool with nylon, nylon will take the load.

And it will take the elastic recovery and the life the abrasion resistance will increase. Now the longer fibre, so fibre longer fibre will have the for same type of fibre.

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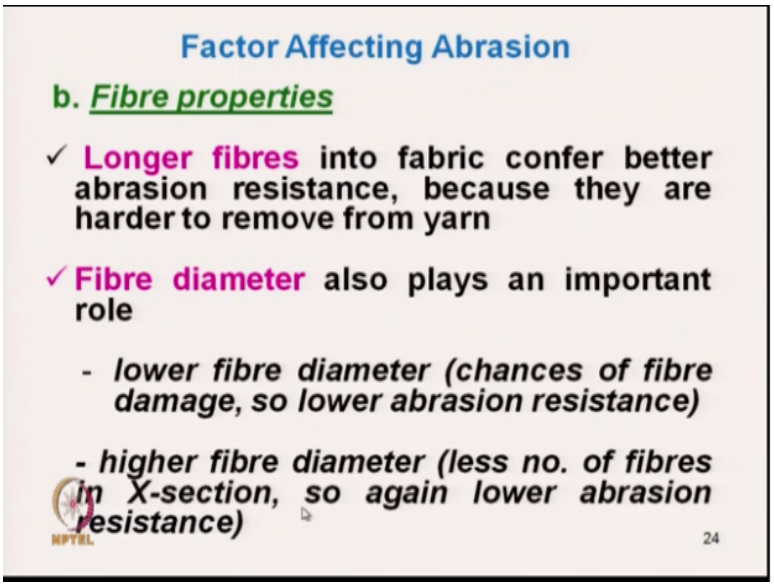

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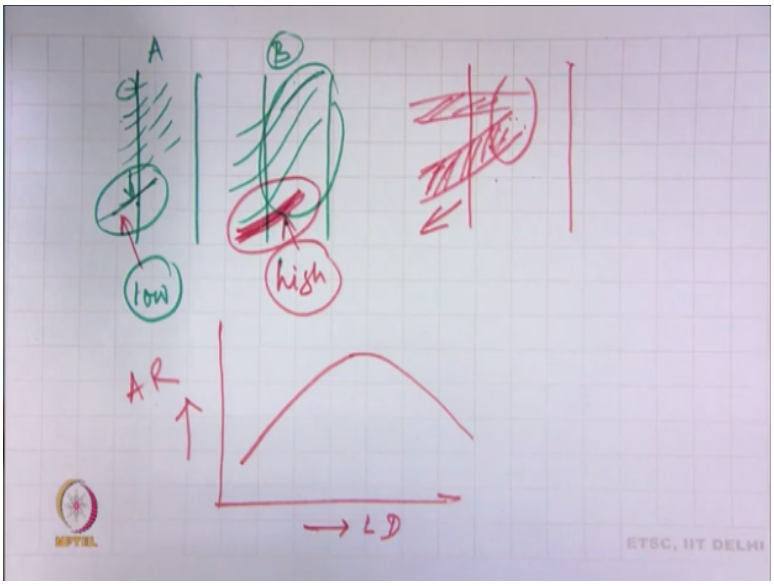

If the fibre is longer suppose this is polyester 1 is made of small fibre smaller polyester fibre another is made of long fibre. So, the small fibre during abrasion will have tendency to come out from the structure and long fibre will remain in the structure and the yarn will be intact even after because the fibres are not coming. So, fibre length, so longer fibre into the fabric better abrasion resistance is there ok.

Because they are harder to remove from the structure, so it will not come out, once the fibre starts coming out that means the yarn will fail. Next is the fibre diameter, now fibre diameter plays a role in 2 opposite way if the fibre diameter suppose a fibre this is a fibre with a fie fibre. And this yarn is made of a fibre with coarse fibre and here it is a fine fibre A with fine B with, now fine fibre during rubbing it will immediately break.

Because of the it strength it will immediately break but coarse fibre will not break easily, so that means the fine fibre will have low abrasion resistance and coarse fibre will have high abrasion resistance. This will have high abrasion resistance but if we keep on increasing the linear density of fibre if we are making the fibre very coarse ok. Now we are making a fibre yarn with a very coarse fibre this is 1 fibre ok.

This is fine, this is moderately fine and then it is a very coarse, now if we are making a yarn with vey coarse fibre what will happen here number of fibres in the cross-section will be less. So,

fibre to fibre equation will be less specific surface area of the fibre will be less, so this fibre will have tendency to come out easily because the holding power will reduce that means if we compare this is the linear density of fibre and this is the abrasion resistance.

That means initially will with the increase in linear density the abrasion resistance will increase then after reaching certain optimum time again it will drop, so the reasons are explained here ok. That is why, so fibre diameter also plays an important role here, lower fibre diameter that means chances of fibre damage is there, so lower abrasion resistance and for higher fibre diameter less number of fibres in the cross-section.

So, again less the few fibres if it comes out from the structure that means the yarn will actually fail because less number of fibres are there in the yarn cross-section.

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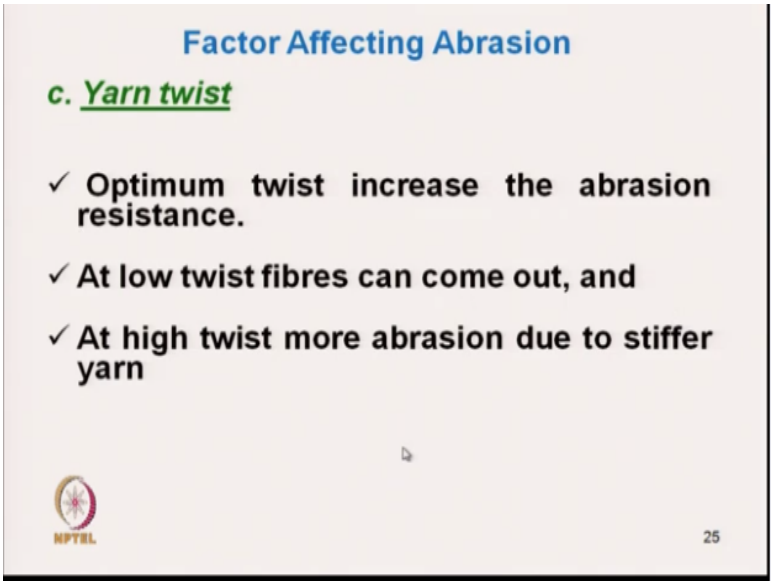

Next is the yarn twist, now yarn twist also plays an important role in the in abrasion.

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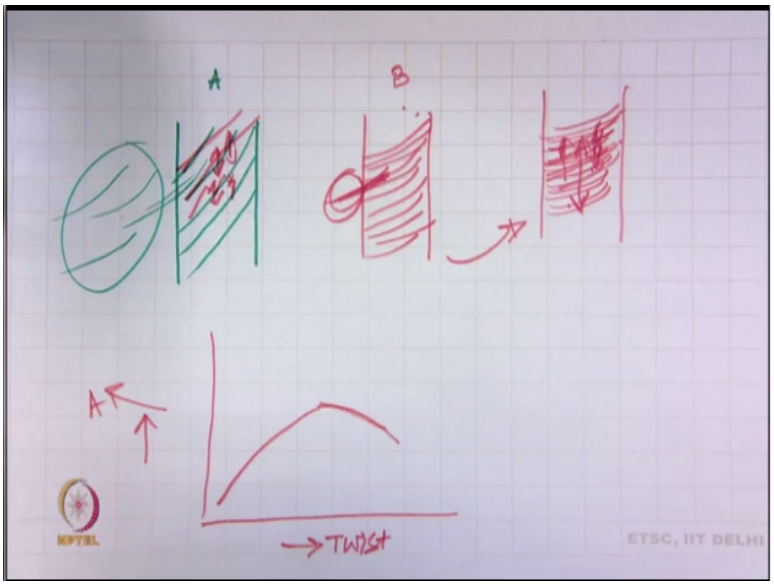

Now suppose we have 2 yarns, yarn 1 yarn A with low twisted same fibre with low twisted ok and another yarn, yarn 2 with high twisted. So, as it is high twisted yarn the diameter has reduced ok that means the yarn has become very compact and this fibre as it is low twisted during rubbing the surface fibre will have tendency to come out ok. This will come out from the structure but here as it is compact this will not come out easily.

So, that means the if we again draw the curve twist verses abrasion resistance with the increase in twist, the abrasion resistance increases ok. That is the phenomena because here the fibres will not come out from the structure and the structure will be intact ok B. Now another case suppose we increase the twist further we have make it very compact, now the type of twist which we have put here it is enough for the fibre to retain the fibre in this structure.

But if we still increase further that means the when we are rubbing, rubbing the this yarn that means there will be few slide movement of yarn due to the rubbing against another surface. There will be movement of yarn that movement will actually absorb some energy this movement of yarn fibres will absorb some energy that means it will not actually rub the this fabric surface too much because of the movement of this yarn fibres.

And this that is why here although it is coming out but the it will absorb some energy but very compact fabric very compact high twisted. Here the individual fibres are very rigidly failed, so

whatever abrasion is there this will abret the surface fibre too much ok. Because there will not be any ok relative motion of the fibres. So, if the fabric there is made of very high twisted yarn then also you will see a drop in abrasion resistance ok.

So, twist, so optimum twist is in required, so optimum twist increases the abrasion resistance, low twisted fibre can come out easily. And at high twist level more abrasion due to stiffer yarn, so we need optimum twist ok.

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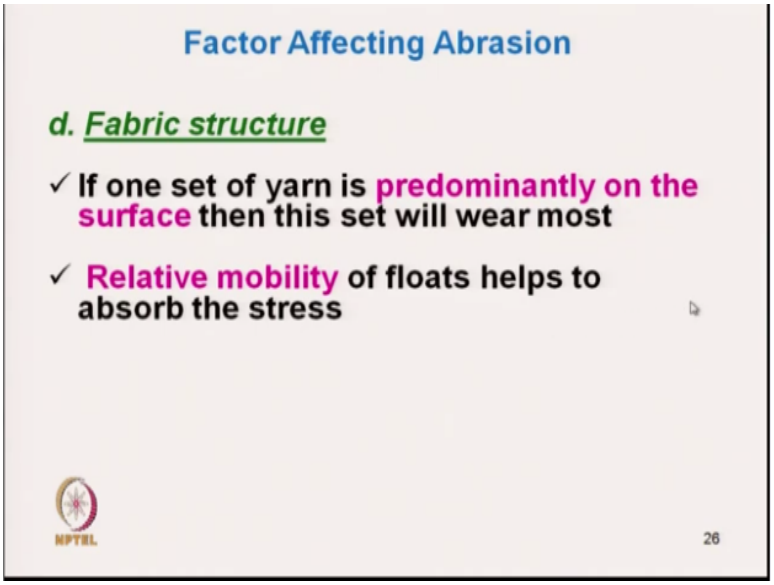

Now fabric structure again a fabric with loose structure same as the twist here that fabric made of loose structure will have tendency to absorb the abrasion energy. During abrasion if the surface yarns move fast each other then the fabric will have higher abrasion resistance. But if we have a very compact fabric structure then the abrasion resistance will be less. So, that is why for same epi, ppi a same yarn if we have 2 fabric 1 is say plain woven fabric another is say satin.

Satin due to is loose structure it will have higher abrasion resistance because it will actually absorb few energy due to the relative movement of yarns. So, if 1 set of yarn is predominantly on the another way is that, suppose we are making say warp fest or weft fest, so satin or something. So, that predominantly 1 set of yarn if it is on the surface that is are that actually total abrasion energy will be actually shared by that particular set of yarn.

And that is why the that the say particular set will wear out most, relative mobility as I have mentioned of floats helping absorbing the abrasive stress. So, fabric with loose structure will have higher abrasion resistance, now coming to the factors which affect the test result.

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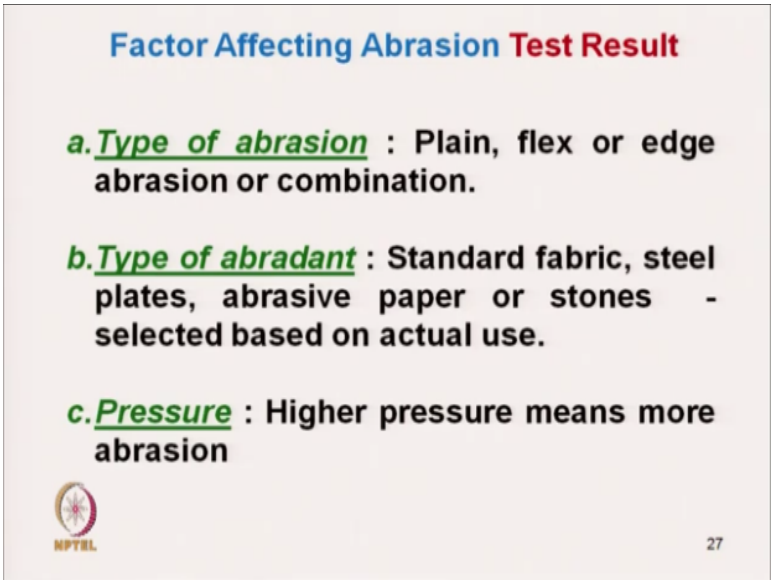

So, if we change one of the factors that will change the test result. So, the study is that the type of abrasion if we as I have mentioned 3 types of abrasion it is whether it is a plain abrasion plain or flat abrasion, flex type abrasion, edge type abrasion or combination. So, that will actually decide the test result. So, that is why for any abrasion test we cannot simply tell that ok this is the abrasion cycle or we cannot.

We have to mention the 1st thing is that what type of abrasion it was and type of abradant we have to mention. So, whether it is a standard fabric or steel plate or abrasive paper or stone that we have to specify, so the severity of abradant will result lower abrasion cycle. Pressure, so at high pressure means higher level of abrasion. So, that means fabrics will have get greater contact, so that will result high abrasion.

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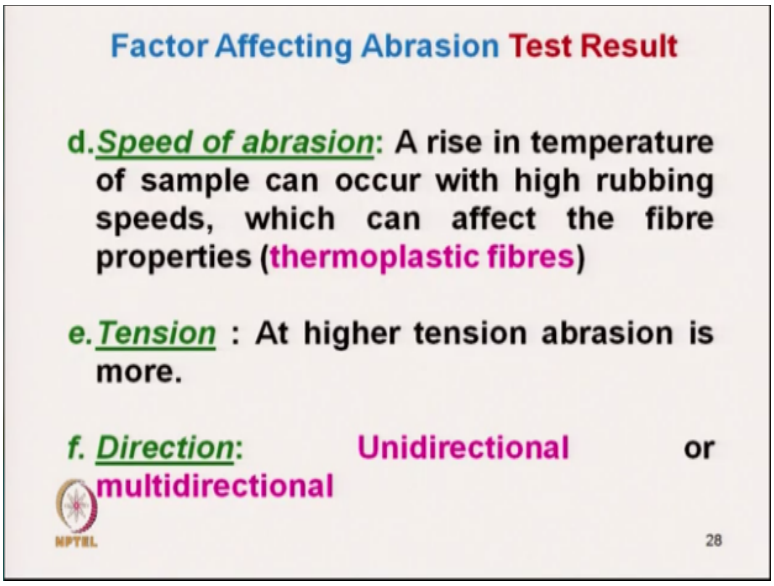

Speed of abrasion is also important because of the rise in temperature, so at higher level higher at higher speed the temperature will increase particularly in thermoplastic fibre that will affect the test result. And tension, this is also important if the fabric sample is put under high tension that means there will not be relative movement and the abrasion will be very high. But the fabric if it is loose and a loose condition then there will be relative motion and that will result higher abrasion cycle before it breaks.

And direction if it is unidirectional then the same set of threads will get abraded repeatedly and if it is multidirectional then the abrasion type will be entirely different. So, we have to mention what type of abrasion we are trying to do.

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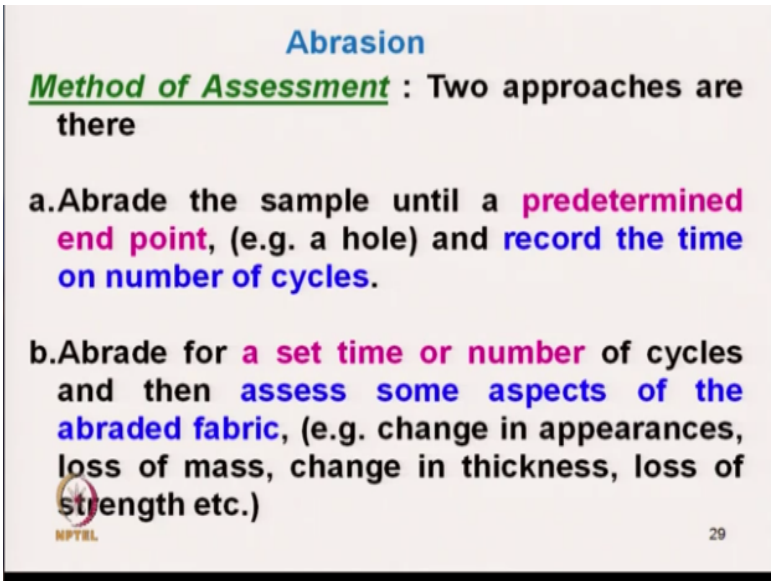

Now the method of assessment, so there are 2 approaches 1 is abrade the sample up to the predetermined end point. That means an suppose 1 hole is forming, so up to that point then we record the number of cycle required to reach that. That is 1 way of looking and another is that abrade for a set time or number of cycle, so that we have actually we have set time say for 1 hour will abrade or for say 1000 cycle we abrade.

Then assess the characteristics of the fabric some of the like appearance loss in mass, change in thickness, loss in strength and compared with the standard un abraded fabric. So, % change we can **we can** do, so this 2 approaches we can actually perform.

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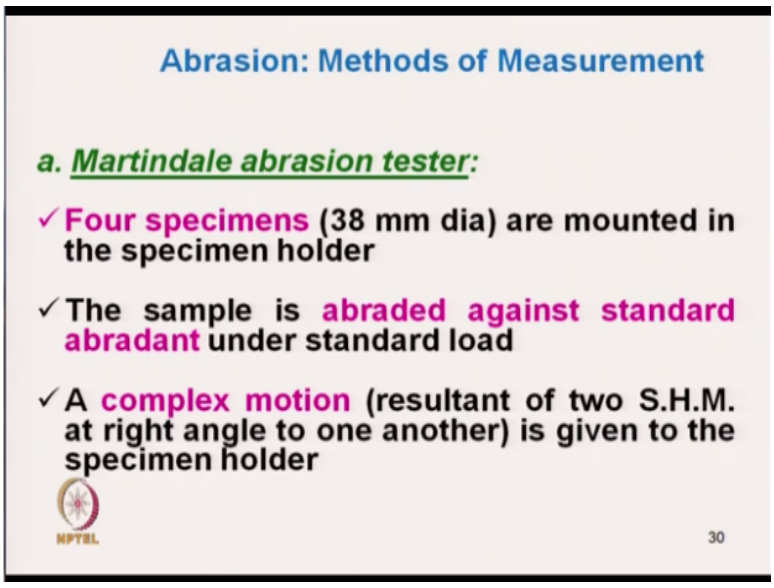

Now the methods are there are several methods one is the Martindale abrasion tester where 4 specimens of 38 millimeter diameter are mounted on specimen holder and the sample is abraded against standard abradant under standard load. And a complex motion is given, so which is actually of 2 simple harmonic motion at right angle. That type of motion is given to the specimen holder.

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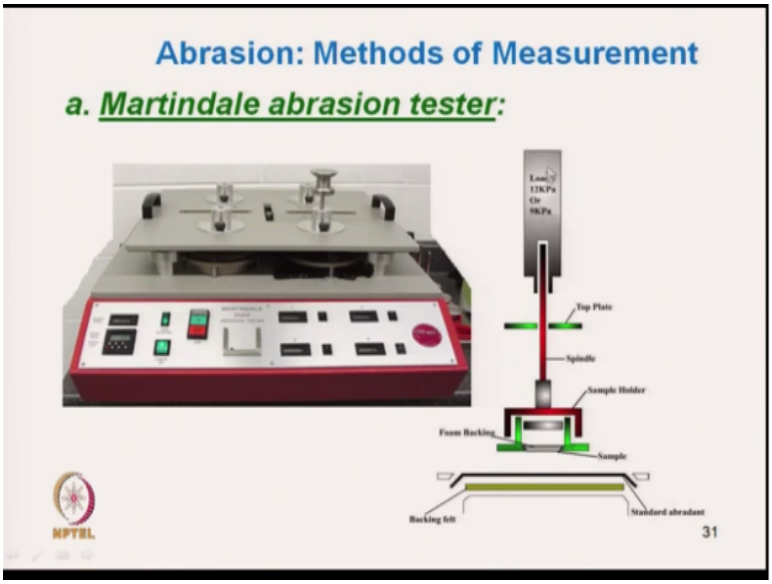

So, this is the picture of Martindale abrasion resistant tester where there are 4 such holders are there and the bottom as we have mentioned earlier. The standard abradant cloth are placed and then the specimen holder hold the specimen here sample and the standard load is kept here ok, standard load is placed and then the machine instrument started. And the this holder this moves as complex makes a complex motion this plate and there will be some movement ok.

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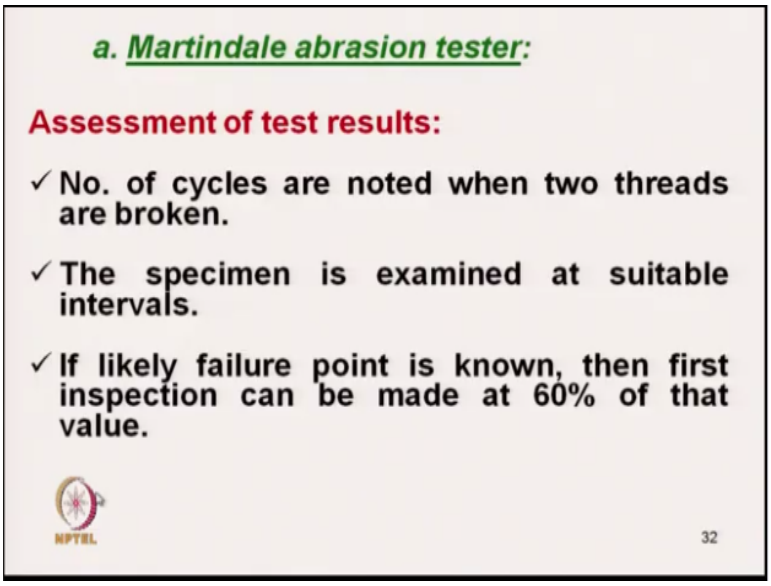

And the assessment of test result is number of cycles are noted when 2 threads are broken, now here what we do. We have to first test the number of cycles we have to note when 2 threads are broken we must stop the test in between just to see that whether the breakage starts or not. And the specimen is examined at suitable intervals, so we have to examine because there should not be any more breakages and if we know the likely failure then we can start inspection from the 60% of that value.

Suppose we know if there will be 1000 cycle required normally for 2 breakage, so we will start with the 600 cycle and keep actually keep observing the condition of the fabric.

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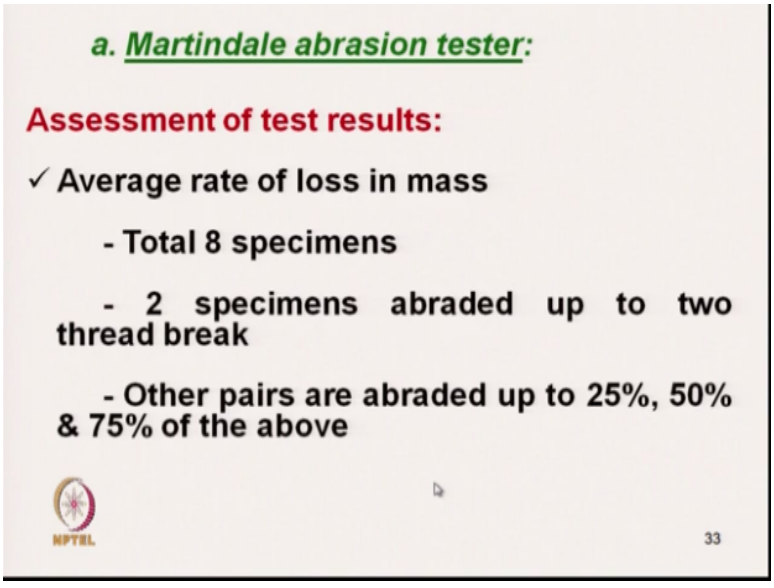

Now assessment of test result normally in Martindale abrasion tester we measure the loss in mass say in milligram/1000 cycle. So, how do we measure, so where what we do total 8 specimens are taken, 2 specimens are abraded up to 2 thread breakage, that is the extreme end point ok. So, that we know that and we note down the number ok we note down the number of the cycles required other pairs are abraded 25%, 50% and 75% of the above means.

Suppose 2 threads are broken after 1000 cycle ok then we will test up to 250 cycle, 500 cycle and 750 cycles, so there are 4 pairs. So, other 3 pairs or 2 specimens for 250 cycle other 2 specimens for 500 cycle and third pair will be for 750 cycle. So, we have got 4 different specimens and then average loss in mass can be measured.

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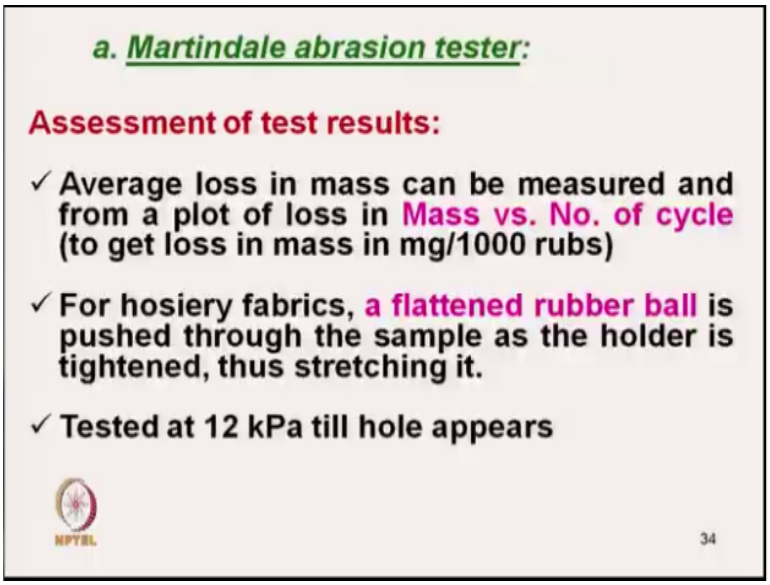

So, for from each specimen we can measure the average loss in mass, so we have got 4 specimens, so average loss in mass we have got and we can plot the curve. Then we can extrapolate to get the loss in mass in milligram/1000 rubbing cycle. So, that is that will give a result ok and for hosiery fabric the due to the extensibility and to make it the severity of the test because in the hosiery fabric the fabrics are actually it is twisted hosiery it is a knitted fabric.

There will be relative movement of the yarns , so that is why the fabric will show the higher abrasion cycle that is a to reduce the abrasion cycle we insert a flattened rubber ball is pushed through the same sample holder and it is tightened. Thus stretching it we have to stretch the

sample, so that we can get certain result ok. And tested under 200 kPa it is a higher pressure, so to till the hole appear otherwise in if we test as per as the woven fabric specification, the testing cycle will be very high because of the lateral movement.

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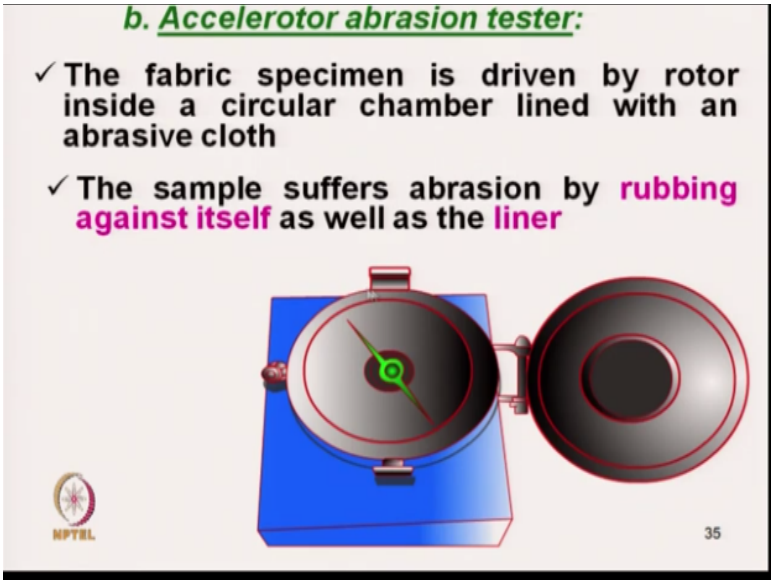

Another measurement technique is the it is called accelerator test where the fabric specimen is driven by a rotor inside a circular chamber ok lined with the abrasive cloth ok. So, this chamber it is lined with an abrasive cloth, so this is the rotor. And after that we cut the sample ok the sample suffers abrasion by rubbing against itself as we as well as the liner, liner abrasion liner is there and we put the loose fabric specimen and then it is covered and rotor is started. So, then fabric stumbled and rub against itself ok and with the liner.

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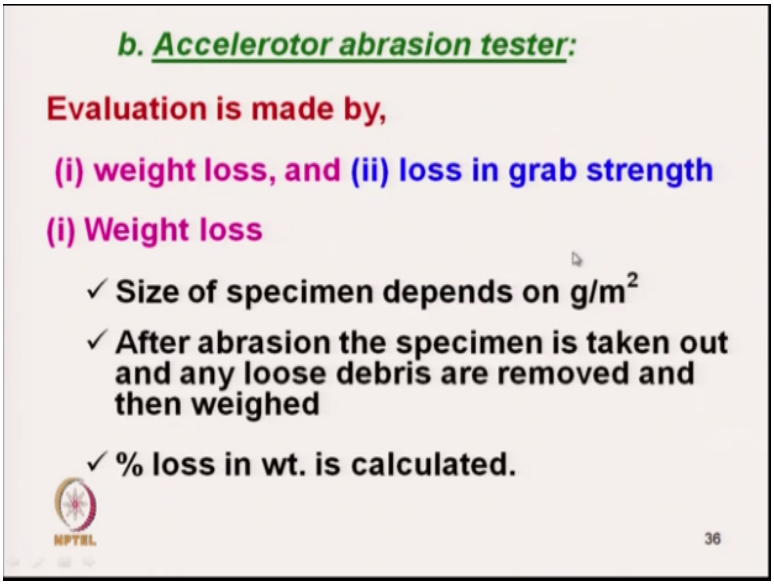

The evaluation method is that by weight loss, so as earlier we can also measure here the weight loss and for a particular time and loss in grab strength. So, we can test the grab strength of the fabric I will just explain. The weight loss is by the size of the sample depends on the grams/square meter, so if it is higher mass/square meter that means the quantity of material will be more, so we will we can reduce the size of the sample.

After abrasion the specimen is taken out and any loose debris or loose fibres are removed and take the mass. So, we will just we will take out all this pills and all any loose fibre any hairs, so this will take out and take the mass and we will measure the weight loss of the fabric % loss is **is** calculated.

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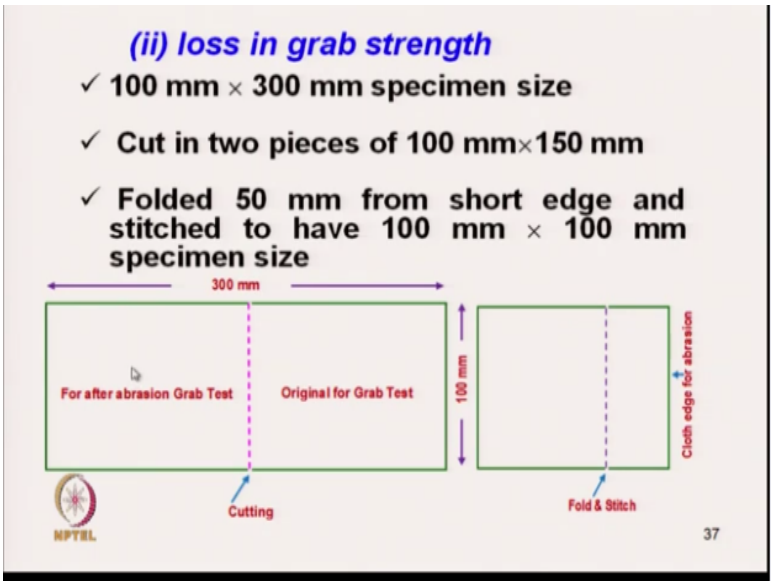

And next method is loss in grab strength where the specimen 100 millimeter/300 millimeter specimen is actually it is cut 10 centimeter/30 centimeter this is the 30 centimeter/10 centimeter, this is a specimen. Now we cut this fabric into 2 equal parts, so that means the specimens are it is a 150/100, so specimen size becomes 100 millimeter/150 millimeter. Now we keep 1 specimen as standard specimen ok this is the standard specimen we keep separately.

Reference specimen, another is that it is a for abrasion testing, this is for this is original for grab test this specimen is kept for as a reference and this specimen we use for rubbing. Now before rubbing we have to actually prepare this sample how to prepare, what we do we fold 50 millimeter from this side, this is 150 and by 10 ok so 150/100 from this side we fold this side by 50 millimeter, so 50 millimeter is folded. So, effectively the fabric size will be and folded and stitched ok, so that we make, so this is the fabric.

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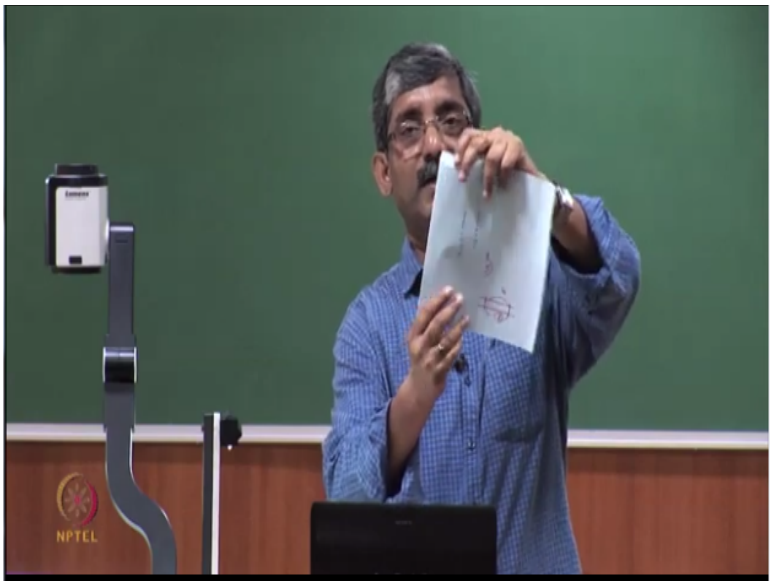

So, this is say 150 millimeter this is 100 ok, now what we do we take 50 millimeter here and we fold it, so effectively the fabric is 100millimeter/100 and then this fold portion is stitched somewhere keep. And this fabric this specimen where it is age is there ok folded age is there, this specimen we place into the testing chamber and where this specimen is being tested and rubbed against the age ok.

So, this accelerate then after certain cycle we take out this fabric and this is this fabric which fold it is it is we have taken out we have removed the stitches and then we test this fabric for the grab strength. And this is the fabric which is being rubbed and this grab strength and another fabric which has been kept separately this reference sample and that we test and we compare the result we compare the loss in grab strength of this fabrics. So, that gives the indication of the inch type of abrasion ok, so folded age is abraded.

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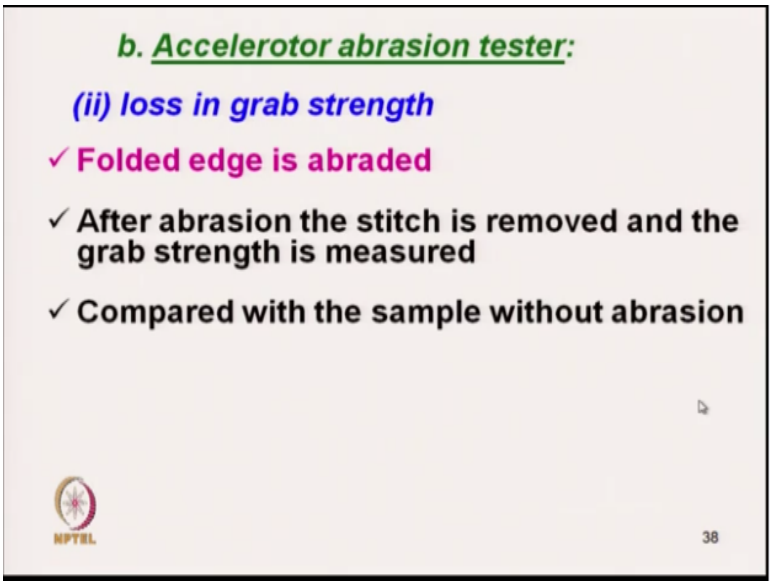

The abrasion is after abrasion the stitch is removed and the grab strength is measured compared with the sample without abrasion say then we can calculate the percentage loss in abrasion. So, these are the ways we can evaluate the abrasion, so here in this session we have discussed various aspect of pilling and abrasion we have discussed the various factors which affect the test result where we can we have discuss how to control the piling resistance or abrasion resistance ok. And we will finish this session here and then in the next session we will start with a new topic till then thank you.