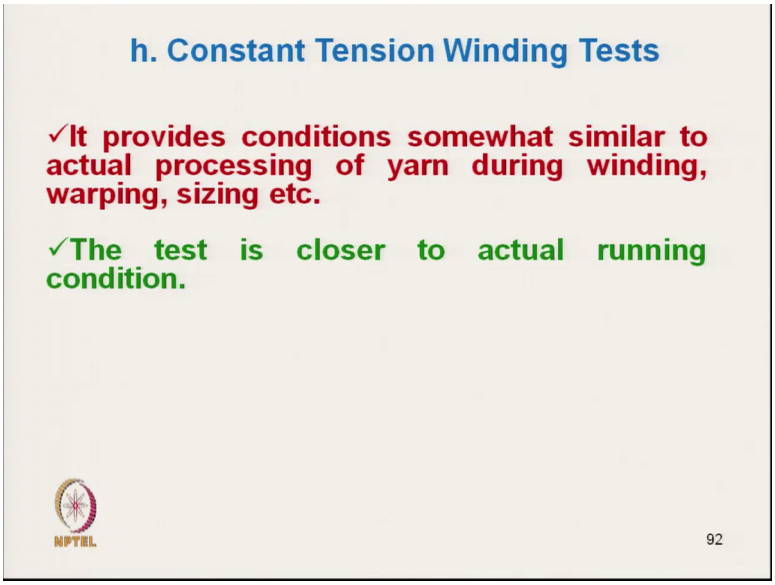
Evaluation of Textiles Materials
Prof. Apurba Das
Department of Textile Technology
Indian Institute of Technology – Delhi

Lecturer -23
Evaluation of Tensile Properties of Textile Materials (Contd.,)

Hello everyone so we will continue with constant tension winding test.

(Refer Slide time: 00:26)

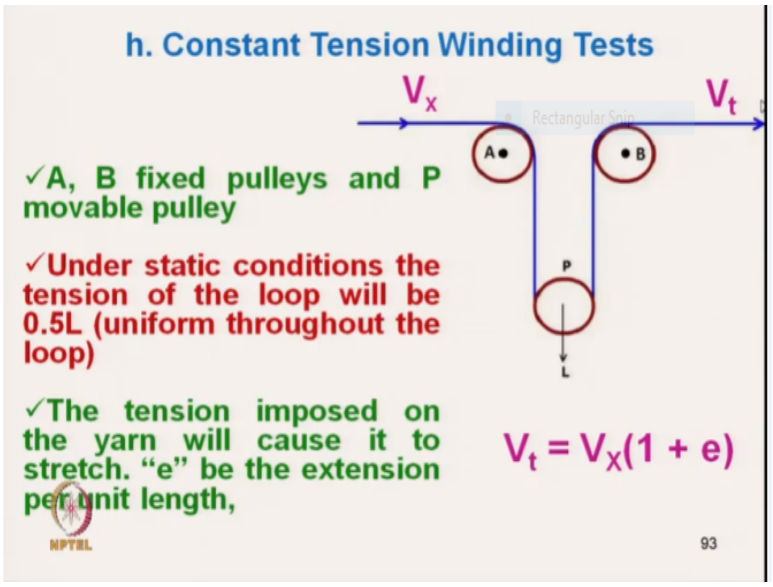


So, as I have mentioned that it provides conditions somewhat similar to actual processing condition during winding, warping, sizing. Basically the most of the breakages occur in the yarn during these processes; winding, warping and sizing after that obviously in weaving also during weaving picking. So, in most of the cases we will see that the system is that winding or unwinding type situation except warp which keeps the almost static loading ok.

So, and after that; after warp we will see, once the fabric is made then the yarn strength does not actually that is not that important, actually single yarn strength. Then comes to the fabric ok and in that case if you see that the majority of the process; running of the yarn undergoes winding, warping and sizing. And this gives the direct indication of the efficiency of the particular yarn in the; its impact of that yarn on the efficiency on the particular machine.

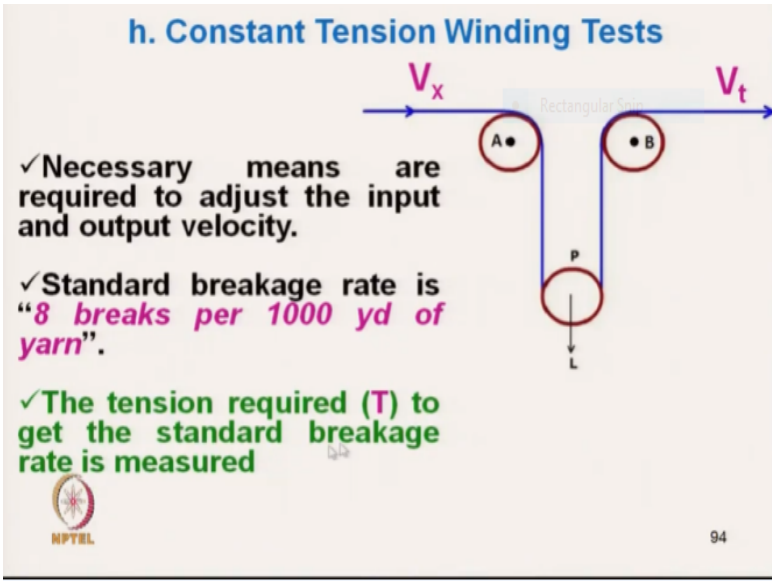
Yarn with very high strength it its breaks during winding it would not; then it will actually affects the efficiency. That is why it is important to know the running condition ok. The strength in running condition;

(Refer Slide Time: 02:28)



So, we have A and B as I have mentioned is fixed pulleys. P is movable pulley. Under static condition the load is divided into two equal parts and when tension is imposed it has got extended, stress by e, so the speed knows that basically input speed * (1 + e) ok.

(Refer Slide Time: 03:04)

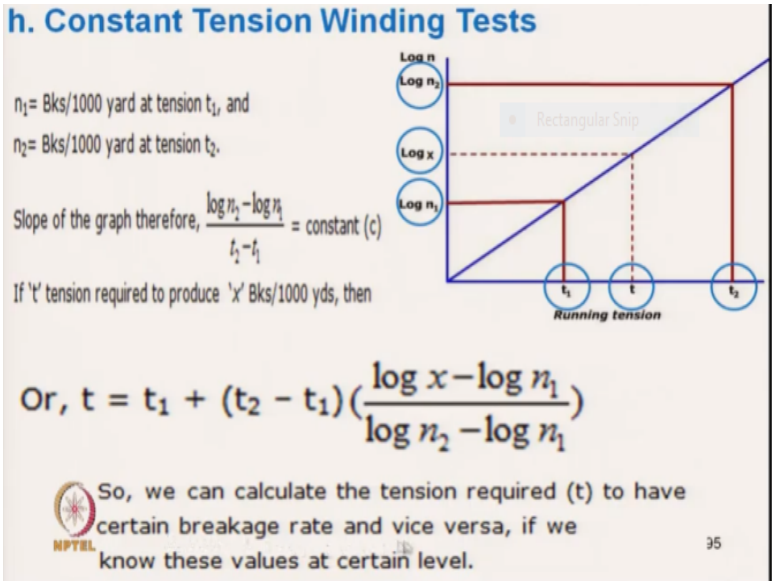


And we have to arrange means so that it can take care of the stretchability. If we know the stretch percent then we can easily adjust the speeds. And standard breakage rate is 8 breaks per 1000 yd of yarn. Now if we know this standard breakage rate then we can adjust this load and that load will be the dynamic load of the yarn. Dynamic load of the yarn means at load said P yarn gives 8 break per 1000 yard that means is the P is dynamic load.

If it gives more than that, then we have to reduce the load, till we get this that means higher value of P means better is the yarn. And suppose we having a load say lower load much lower than P in that case if it does not break running smoothly that means we are not getting in any indication similarly, in the static condition if the yarn does not break; if material does not break, then will not get the strength.

Similarly dynamic strength only we will get if it breaks repeatedly and that is the 8 breaks per 1000 yd, the load. The tension required T to get the standard breakage rate of 8 breaks per 1000 yd is measured ok. So, if it is higher than 8 breaks per 1000 yd then we have to reduce the load to bring it to such a value which gives exactly the 8 breaks per 1000 yard.

(Refer Slide Time: 05:01)



Now, there is relationship, the relationship that for a yarn n1 is the break per 1000 yd at tension t1 so this the; in x-axis is the running tension ok tension giving T1 and n1 we have got the value and Y-axis plotted; the log value of n1, it is log n1. So, there is a straight line relationship between the tension and the logarithmic value of number of breaks per 1000 yd. So, for t1 tension there is a breakage rate of n1, which have a value, so log n has been put here**.** Similarly, for tension t2 the breakage rate n2 breaks per 1000 yard, so this is the plot t2 tension and log n2.

Now if we plot a straight line curve; this is straight line from there we can get any unknown value so in that case we can actually predict what will be the number of break at what stage that is the indication that will get almost almost which is actually which works. Here the

system is that; the thing we cannot get in this instrument we cannot get 8 breaks, getting 8 breaks per 1000 yard is impossible, it takes large number of testing.

It will take large longer time because we do not know suppose we want unknown tension given suppose it is coming say 50 breaks per; and another unknown tension we have to giving is say 30 so how long will he go, we cannot go infinite so to get exactly 8 value that is why the system is there we test the yarn in 2 different strength tension value t1 and t2 which will give us some value of n. So, t1 test at tension test we know n1 we have reached.

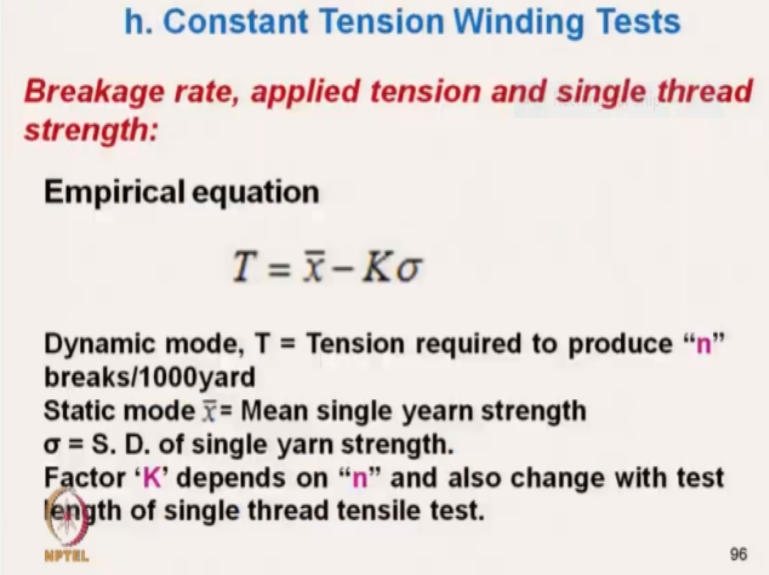
So that means log n1 we have put t2 we have increased, the tension t2 we have got higher n2 value, the log value we have put and simply we have put the stretch line. Now what we have to reach here, we have to reach the value standard value which is nothing but 8 breaks/1000 yd. Now to reach this 8 breaks/1000 yd that means log of 8 values we will take y. In y-axis we will find where is log of 8, this 8 value X = 8 if it is standard, we simply tell this is the t value, t value is the; which we actually want know that is the t value from which we compare this is the standard rate breakage rate t and the slop of the curve is that log n2 – log n1/log n2-n1 while this is the; this height divided by this distance divided by t2 – t1that is the slope tan theta.

Slope of the curve we can get which is constant and this is here and standard value any standard. For BS standard it tells is a 8 breaks/1000 yd in any other standard any known value suppose for our purpose we want to know at what tension the breakage will be 1000 or 100 breaks so we can simply calculate and get the value, extrapolate the value. So, this is the standard value that means if our standard is x, 8, so we can calculate the tension requires t or get the value 8 using the simple formula straight line this is; what is that but y=mx + c so we know this value that constant here from there we can calculate ok.

So, we can calculate the required tension if we know, if we want to have any other any know value or in vice-versa also. If we know the tension we can predict how many breakages will be there that is also important. Here in this test if we can plot for a particular yarn, if we can plot for this curve using t1, t2 and n1, n2 if we can plot then this will help us in setting the tension in winding, warping or sizing.

So you can come to know that what will be the probable breakage at that. So, if we set the tension t then we know there will be x breakage/1000 yd, so from there we can predict. So, this will give us a clear idea of performance of yarn during running.

(Refer Slide Time: 11:17)



Now there is a empirical equation, this empirical equation gives a relationship between the dynamic tension with the static strength ok this is beautiful equation which will give; which will solve many problem. I will discuss one practical problem and this sigma is the standard deviation of single yarn strength. So, here this is the; probably the only equation empirical equation which keeps the relationship between the dynamic strength verses static strength where k is the constant which depends on the n number of breaks and changes with the length of the test length.

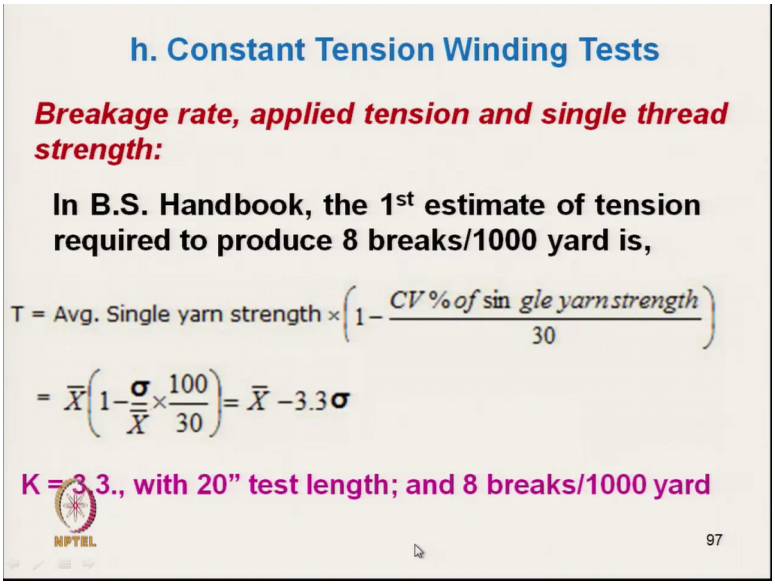
So, this k value it changes with the number of breaks and test length of the single yarn strength. So this value k depends on both in static mode that is static mode what is that it is the test length gauge length and in dynamic mode it depends on the number of breaks. So, k value it changes but so as per bit this value, static mode, so this gives one relationship between static and dynamic that means if we know the breaking strength for the particular gauge length it will idea about k value.

And if we know the variability of the yarn strength then we can come to know the tension required for a certain number of breaks that means here if we see this standard deviation that means for a keeping other x say for a particular yarn with certain mean strength mean

breaking strength. If we increase the standard deviation, suppose variability of the strength is increased then what will happen?

This will give as idea about this value will reduce. The T will reduce if we change the variability the standard deviation increases that the T value will reduce that means the n number of break per 1000 yard will occur at lower tension. Then the yarn strength is; performance is poor at lower tension it will break ok. Similarly if the yarn strength is high keeping the standard deviation constant that means the tension required for certain number of breaks will be more.

(Refer Slide Time: 14:48)

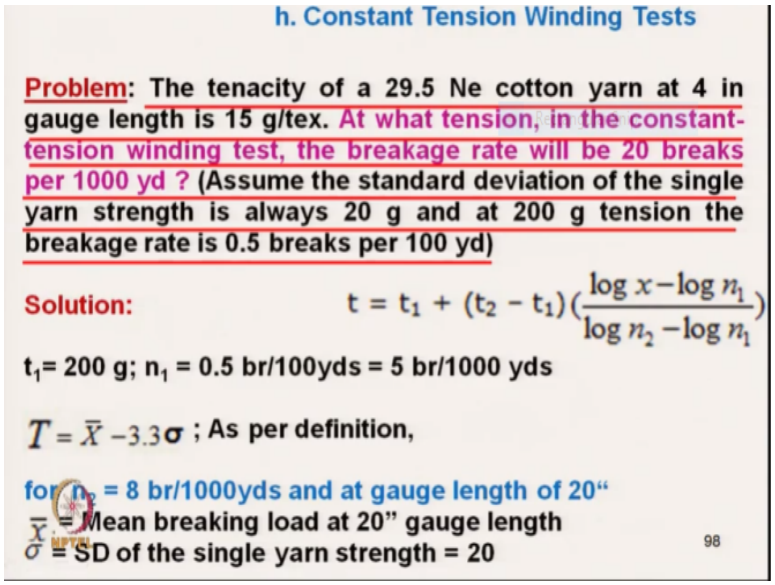


So in BS standard handbook the first estimate of tension required to produce 8 breaks/1000 yard, so that 8 breaks per 1000 yards is the standard breakage rate and they use this formula. What is the formula T=average yarn strength * 1-CV% of single yarn strength by 30 and this is given in BS standard handbook and if we specifically follow this now what are you reaching this X bar that is single yarn strength T is the tension required for standard breaks of 8 breaks /1000 yard ok and 1- what is CV? CV is nothing but standard deviation/X bar*100/30 and if we see it is become X bar - 3.3 standard deviation.

What does it show the k value become 3.3 here, k is 3.3 here for a particular situation as you have mentioned the gauge length, what is the gauge length? In BS standard handbook they say test length should be 20 inch and n value we have mentioned earlier n is 8 breaks /1000 yard. So, only for test length 20 inch and 8 breaks/1000 yard if we considered then the known value is for k is 3.3.

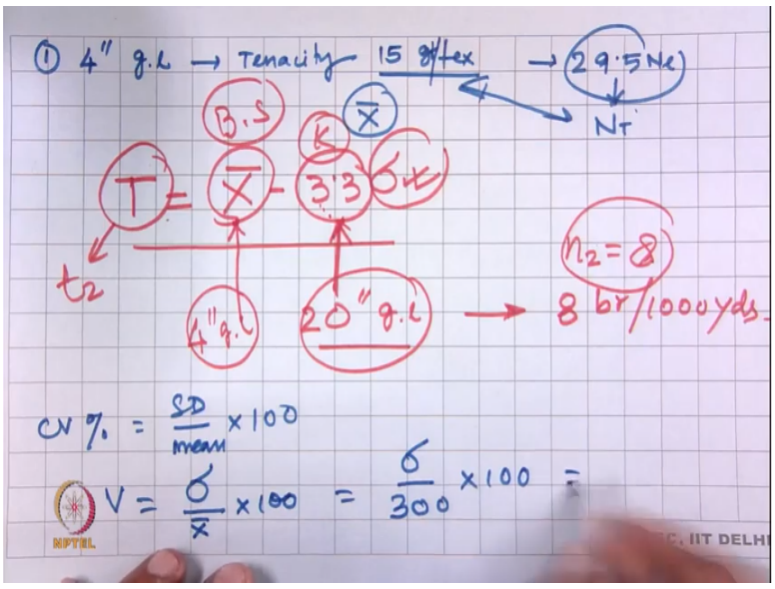
And if do not know; if we change all this value 8 and 20 then k value will be differed. So, if we want to use k as, 3.3 then we have to set this value, we have set the gauge length for this static test and you have to set t value, the breakage rate t in such a fashion that the breakage rate becomes 8 breaks/1000 yard only in that case the k value will be 3.3.

(Refer Slide Time: 17:33)



Now see one numerical here basically it takes care of many concepts and we have to see very carefully to solve this problem and this will give us clear idea about the application of the; practical application of this tensile tester, this tester. And here if we see that what it is telling the tenacity of the yarn 29.5 Ne cotton yarn at 4 inch gauge length is 15g/tex. So, here condition 1;

(Refer Slide Time: 18:33)



At 4 inch gauge length tenacity here it is a 15g/tex ok at 4 inch gauge length. And what is yarn Ne 29.5 Ne yarn, so we can convert it in to tex, Nt, you can convert this one and multiply this, what we will get, we will get the strength; we will get the mean strength X bar ok. So, the question is at what tension, it's given in the core, whatever the question we have put in pink colour ok at what tension, in the constant tension winding test. The breakage rate will be 20 breaks/1000 yard.

So, the requirement is that at tension you want to get for 20 breaks/1000 yard ok. And assume the standard deviation of single yarn strength is always 20g standard deviation is given and is constant and another condition is that we have tested the same yarn which gives the 200g tension the breakage rate is 0.5 breaks /100 yd. So, at 200 gram tension the breakage rate is .5 breaks/100 yard this is; there are 100 yards one condition is that the yarn is tested at 4 inch gauge length it gives the breaking stress at 15g/tex and what we want, at what tension the breakage rate will be 20 breaks/1000 yd ok.

Now try to solve in step wise and let us see and this is the equation as we know ok. This is the required tension and standard value of breaking; number of breaks, t1=200g that is t1, here we are try to; this is t1 ok, last condition this t1 we are trying to get so 200g and it is .5 breaks/100 yd means 5 breaks/1000 yds. So, this will become n1 this parameter is known, so for everything for any calculation as we know, we have know 2 data point t1 is straight away given.

Now t2 how will you get? So, you want to measure t and x value, so this is we want, what tension t value, this is we want and x value is given 20 breaks /100 yd x is here 20. But we do not know the t2 value and we do not know the n2 value. Now how do we get? To get because we have to have 2 data points. One data point is straight away is given. Now we have to find another data point.

For that data point there is some clue here given tenacity is given at 4 inch gauge length it is15g/tex that means 15g/tex is the static mode gauge, static mode, so the equation which we know this equation, in the earlier slide we shown. In the static mode this k value is 3.3 is only valid with the 20 inch gauge length this k value only we use 20 inch gauge length and this 8 breaks /1000 yard.

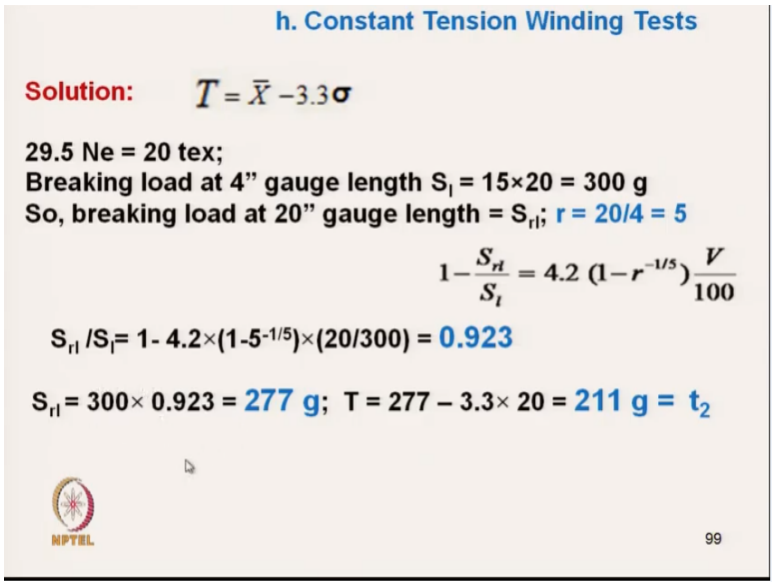
So, in that case if we considered n2 as 8 and if we can calculate the T value and this become t2 and clue is that here we have to; we do not know the other k value, we know this k value that means we have to get this X bar that standard deviation is given is constant but we have to get X bar as per the BS standard. What is BS standard? BS standards say that, 20 inch gauge length. But in our case X bar is at 4 inch gauge length.

So, here it is a 4 inch gauge length data is given now we are get the data this strength with the this strength, with 4 inch gauge length with 20 inch gauge length that means how do we do? In last class we have discussed gauge length, how to measure, how to get the tensile strength. How the strength value changes that we will use here. Now n1 is know this is the value, here the k value we have assumed, we have taken, we have to use this equation ok, we cannot; here n2 is fixed, n2 is as per the standard n2 is fixed, 8.

Now we have to get the T value this t2 value. So, the gauge length is known. So, this X bar is the mean breaking load at 20 inch gauge length. If we can get this X bar value then the T value will be t2 value and standard deviation here is given 20 for all the condition. Always standard deviation is 20, so we will use this here t value; standard deviation of t, this 20. This -3.3*20 –66 is fixed, we known.

But what about X bar now we have to get the X bar, to get X bar, you know the value 15g/tex is given from there we will try to get the value breaking load.

(Refer Slide Time: 26:57)



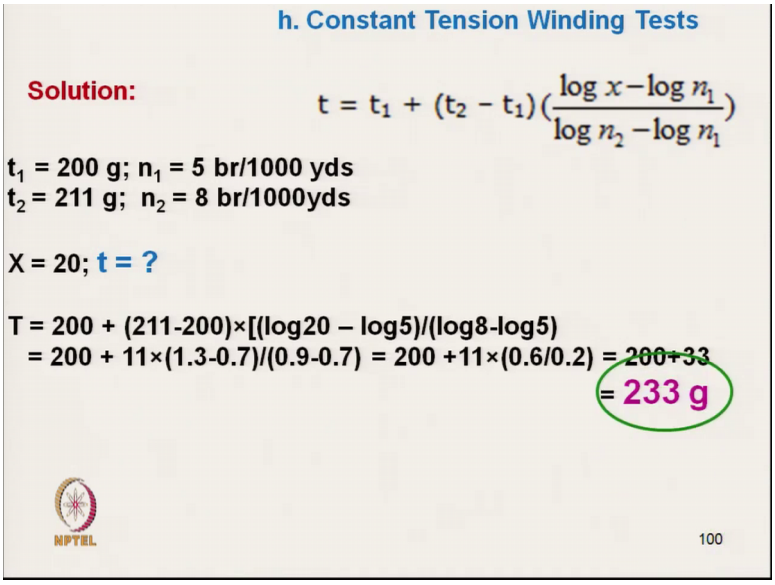
So, 29.5 Ne means 20 tex yarn and at 4 inch gauge length the breaking load, the breaking tenacity was there 15, now converting it to breaking load 300 gram force. Is it X bar? It is not X bar till now because here gauge length is 4 inch we have to convert this gauge length 20 inch then only; the whatever the load will be the X bar. The breaking load at 20 inch gauge length; so we will use earlier equation that Srl with r is nothing but 5, 20 inch/4 inch r =5. So, we will use this formula here.

In this formula we know the all this value except this rl ok. Sl is known, Srl we have to calculate that means that 20 inch gauge length. At 4 inch gauge length the breaking load was 300 Sl/Srl=1–4.2 this we will bring to left hand side ok. So, we will just interchange 1–4.2, 1–5 r=1-5 to the power of -1/5 and this value what is the V/100 CV%/100 means the; this standard deviation by mean value.

Mean value means 300 it is mean breaking strength 300, so V is nothing but V/100 is nothing but, 20 standard deviation / mean strength ok. So, that means it is coming out to be; so we can see CV% is nothing but standard deviation/ mean*100, here V=sigma/X bar*100 or sigma/X bar is 300 * 100 so, basically it is a 20/300*100, so V/100 we can write as 20/300 ok. So, that is replaced here so, 20/300 so if we calculate this value we will come out with the ratio of Srl and Sl becomes; comes out to be 0.923, so Sl, what is Sl? Sl is nothing but mean strength at 4 inch gauge length which is 300.

So, Sl means it is coming out be Srl 300*0.923 it is 277. What is 277? This is the strength, breaking strength for 20 inch gauge length. Now we have reached that value. This is nothing but the X bar in this equation. So, now we can get the T value 277–3.3*20 it is coming out to be 211 gram force which is nothing but t2 value. Now what we got t1, we have got n1, we have got t2 we have got, n2 we have got and we know the value n2 is 8 breaks/1000 yard.

(Refer Slide Time: 31:31)

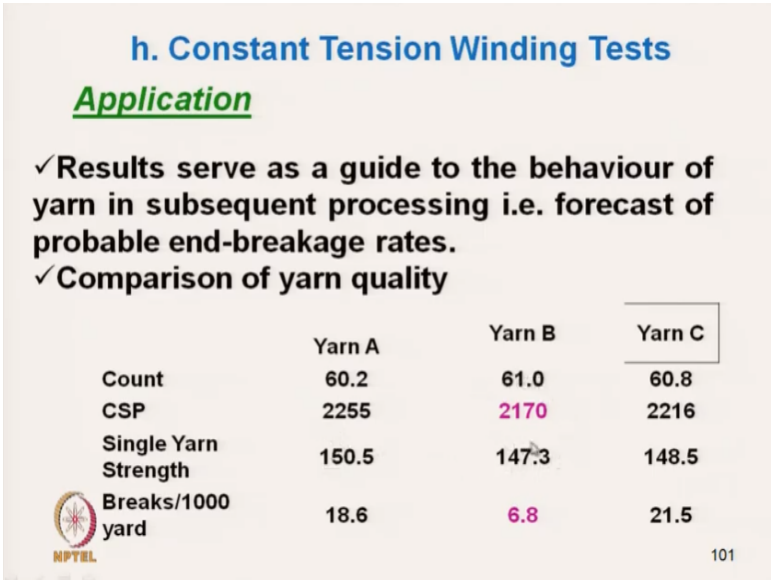


So, t1 is 200g force, n1 is 5 breaks/1000 yard it is given, and just now we have calculated t2=211g force, n2 is 8 breaks/1000 yd that is the standard you know; the X, we know the X value is known it is 20 and then we have to calculated and X is 20 breaks that is the question at what is the tension to get 20 breaks/ 1000 yds, X is 20 and we have to calculate the T value and using the simple formula.

The same formula we can use So 200 t1+200t2 211–200*log 20X–log n1 is 5 / logn2 is 8 – log5 this if we just simply solve we will get the value which is equal to 233g force that is the actual result. What does it show? If we know the basic of this test method we can calculate anything provided we have some raw data and condition here is that here we are trying to see the; we know the statistics.

Ok, if we have two dynamic loads value then it is little bit simpler. But if you have static load if we do not know the k value there we have to use the BS standard known standard. We will go for 3.33 values with the condition then we have to use the exact condition and gradually we have to proceed ok. So that this is typical problem one can solve. In the industry applicability we can set the tension otherwise if set the wrong tension then it will affect the; unnecessarily affect the efficiency of machine ok. We can set that is the value.

(Refer Slide Time: 34:06)



Now the application here the results are guide to the behaviour of yarn in subsequence process. So, it will give us the guide, so if we know the breakage rate for a particular tension that will give us the probable n breakage in subsequent process, n breakage in warping, n breakage in winding or sizing accordingly we can set the tension it gives an idea and comparison of yarn quality.

We have two yarns basic problem is that weaving industry the some processing industry they purchase yarn from the buyer ok supplier. Normally we do not test and we test and we get sample by knowing the tensile test ok in the static mode. The problem is that the yarn with higher tensile value if it gives the higher breakage rate then it affects the actual efficiency of the subsequent process.

That is how, so if we see here three yarns are there yarn A, yarn B, yarn C now which yarn is actually I have to purchase if we get, someone tells definitely we will go for this yarn it a higher CSP, higher single yarn strength which one is stronger higher CSP, higher single yarn strength its good yarn without testing the dynamic mode. Once we test the yarn in dynamic mode then our decision will be entirely different.

In dynamic mode if we see the result although yarn B has least CSP means count strength product least CSP it gives least breakage rate that means the yarn B is expected to give higher efficiency lower stoppage during running ok at least 3 times so yarn A although it is giving higher CSP or higher strength it is breakage rate is 3 times higher than this almost. So that

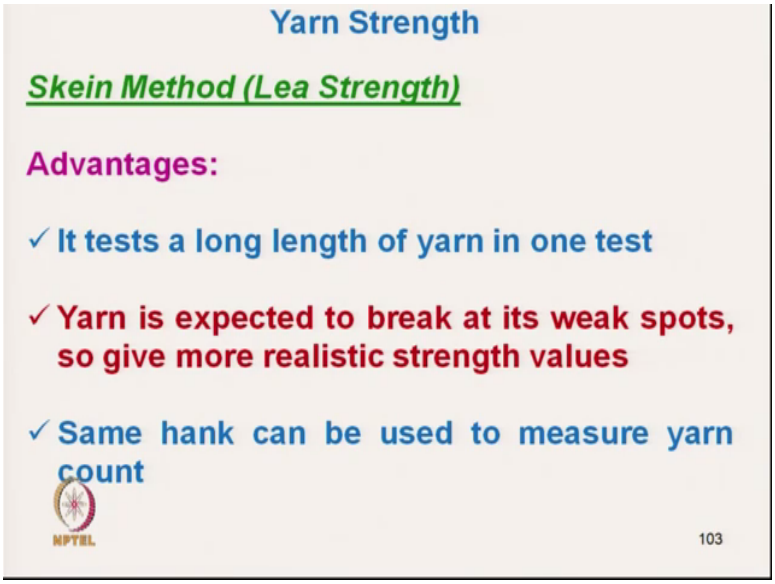
means it will give poor performance ok this yarn B and this yarn C also give poor performance.

As far as the performance is concern the one should prefer the yarn B ok and the strength if we see is not that low although it is lower than yarn A or B but this is not that low it is workable. If we take the yarn A as CSP strength its performance will be poor.

(Refer Slide Time: 37:37)

Next is that single yarn strength testing UTM universal test machine is used which works in the strain gauge principle. And normally strain gauge principle is length is 50 cm, 500mm ok and speed is adjusted so that the time to break is reduced 20 +-3 second, that is the; you have to adjust the speed in that during that time it breaks.

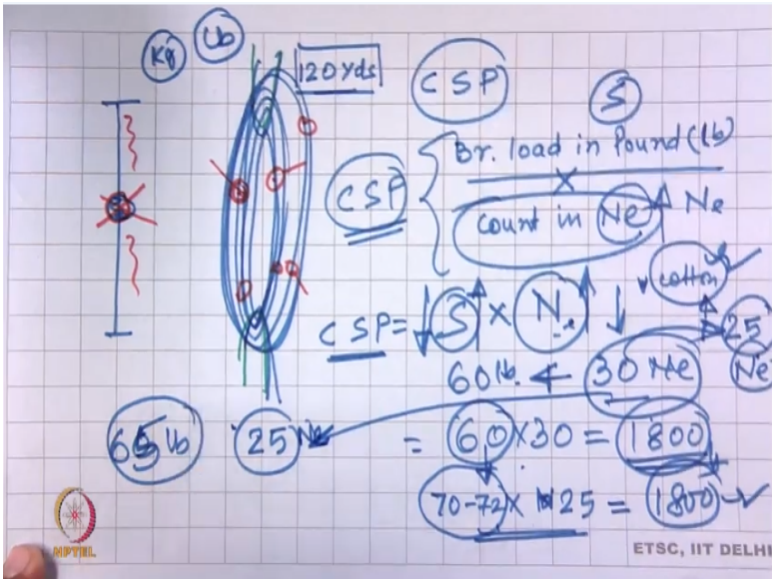
(Refer Slide Time: 38:12)



Now after single yarn strength another strength measurement is there, another type of method that is skein method that is the lea strength method. The advantage of lea strength is that at a time we can test longer length, larger size of length ok, typically it is a 120 yd of length of yarn we make lea and we test. So it test, longer length of yarn in one test ok. But normally in other single yarn test what we will do? We test smaller test and number of sample you have to test.

Second advantage is that the yarn is expected to break at its weakest spots. So, the lea is prepared and this yarn in single yarn strength breaks once ok at its weakest spot. But one the lee form the continuous lea form it will start breaking at different point ok.

(Refer Slide Time: 39:33)



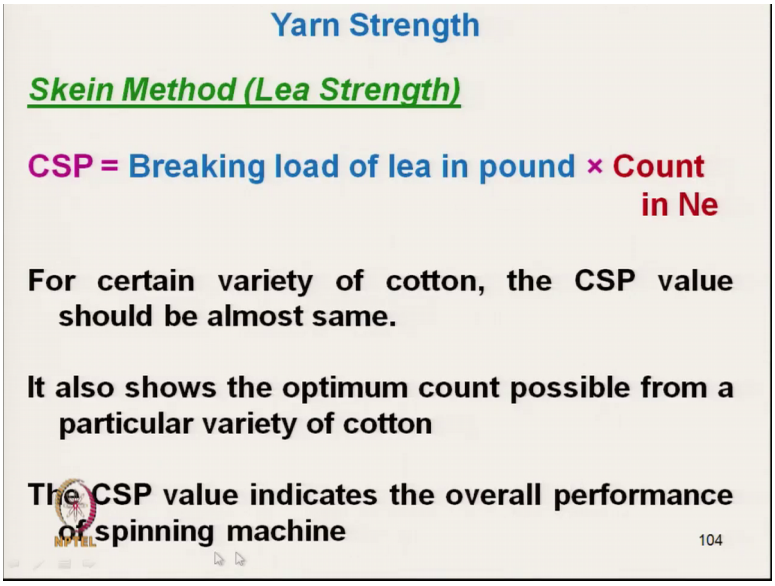
The thing is that suppose it is single yarn strength it breaks at this point. But if it is lee large number of this; what we are doing there are the jaws, this is top jaw and this is bottom jaw ok. Now here this yarn has got different weak spots are there. In single yarn strength there is only one weak spot we do not have any idea about other weak spots which are little bit stronger than this point though we are not getting any idea.

Next that is the end of the test but here the advantage is that depending on the position and location of the weak spot and strength of the weak spot this will start the yarn will start breaking, the first and this weak spot will break, this will break and depending on the strength this will break. This will give over all idea of the weak spots different weak spots present. If the numbers of weak spots are more, then the lea strength will be less, least.

Otherwise it will not stop at the particular weak spot, suppose in that yarn only one weak spots are there. That means given after breakage that weak spot the test will continue the yarn will also have certain strength the strength will increase ok strength value is increased. So that means one weak spot will not basically give us the total and it will not stop test. So the yarn is expected to breaks at the weak spots so that it keeps more realistic strength value it will not stop there ok.

Obviously the same hank we can used to measure the yarn count now the hank which we said 120 yd we have used here. This is the 120 yd and here we have got certain strength ok in terms of kg we can get in terms of pound also we can get ok.

(Refer Slide Time: 42:41)



Now here the value, the terms comes CSP is nothing but count, strength, product ok, now why it is product? Why not it is a division? Count, strength division why not it is something else? Basically the thing is that here the breaking load here is expressed in terms of pound one should be very careful. This CSP is nothing but product of breaking load in pound lb multiplied by yarn count in Ne no other unit. That gives us idea about CSP.

That is why the concept of CSP comes from the lea strength the yarn strength in Skein form ok. It is not the single strength, not in any other form, in form say bundle, it is only you have to have yarn lea of yarn 120yd ok that means breaking load of yarn lea in pound multiplied yarn count in Ne that give the idea of the value of CSP. Now the thing is that, you can see the value here, CSP is nothing but the strength in pound and Ne count is N is multiplied by N. Now this value the yarn we have prepared yarn from particular cotton, particular variety of

cotton ok and we have a got a count of say 30 Ne and we have got strength of certain strength say 60 pound.

So, what will be the value CSP 60*30=1800 typically CSP does not have any unit. It is a CSP count strength product and it is known count pound and Ne. Now this 1800 value what does it indicate? Why it is product? It's the yarn, from the same variety of cotton, same cotton and same set of machines. I am producing say 25 count yarn. So, if I produce 25 count yarn in that case what will happen, 25 counts is coarser or finer. It is a coarser than 30's count.

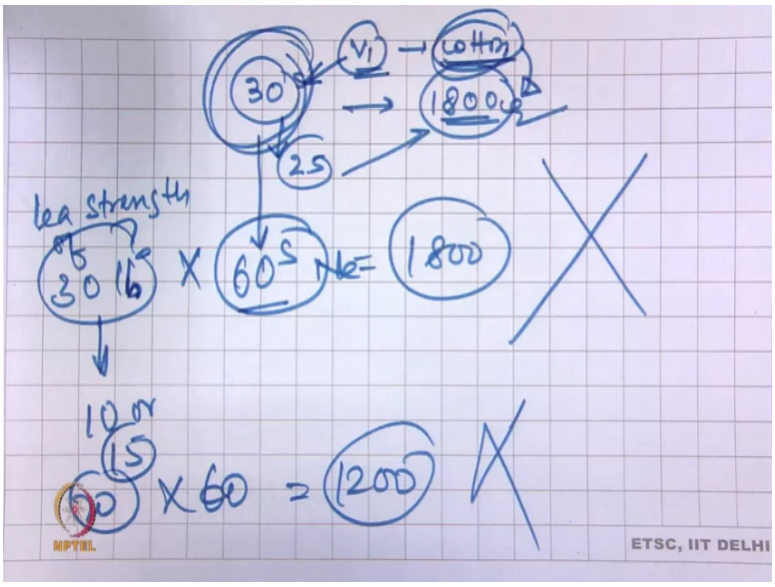
So, it is a Ne is 25 now what is the expected load value, breaking load value the expected breaking load will be typically say around 70 to 72 definitely we have to have this, expected so that its value product its coming out to be exact very close to 1800. That means if we make the yarn finer the strength, if we make the yarn finer by increasing the value then the strength value will proportionately reduce ok. If we make the yarn coarser by reducing the Ne value the strength value has to; from 60 to it has to come to 72 or 70 so that we will get this value.

Now what will happen if we assume, if we are producing say 25 count and we are getting the value of 60 or 65, so 65 pound we are getting for 25 same cotton we are using and we are instead of 30's count we now producing 25 Ne but we are getting 65 pound. So, I would like to know whether this 65 pound is perfect or not because earlier it was 60 pounds now it has increased we have made it coarser 30 to 25 and from 60 it has become 65.

Should I be happy with that, just to have this indication we will multiply this two and we will definitely get value less than 1800 ok. It will give value much less than 1800 it means something is wrong with this yarn, what does it indicate? It indicates that the process the manufacturing process of this yarn 25 count yarn there is something wrong. Because we have used the same cotton with similar production line should result same CSP value.

For certain variety of cotton the CSP value should be almost same that is the indication, the importance of CSP one must understand carefully. It gives an indication of the performance of your machine ok that is one aspect.

(Refer Slide Time: 50:24)

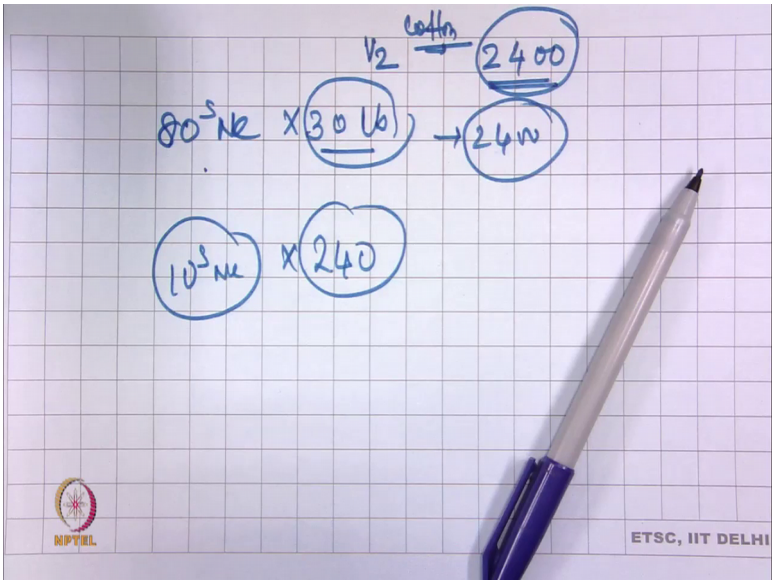


That means if we change the count little bit, if we change 30's count of cotton, variety of cotton of V1 variety cotton ok, its meant for 30's count and we know this cotton will give if the machine perform perfectly optimum perfection, it gives the CSP of 800 that means the variety of cotton its indication is 1800 shows the nature or quality of the cotton, if you and; this will gives the indication, this particular variety of cotton will give; will be used for this count 30's count around 30's count.

Now if we reduce the count make it 25 count it should reduce and give the value 1800. Now for this cotton variety of V1 is it true that if we produce any count this must; this is always 1800 CSP? No. Suppose this variety this means 30's count it is medium variety cotton. Now If we try to produce yarn of 60's Ne very fine quality we want to produce will it give us strength of 30 pound lea strength of 30 pound so that we can get 1800 CSP? No, it will not give, this variety of cotton if we; it is meant for 30's count.

If we try to produce 60's count it will try to give much lower value say 10 or 15 or 20 pound strength it is producing and 60, 1200 CSP that means it is; we are actually trying to overuse this; we are not trying to use the actual potential of this machine. This cotton is meant for 30's count range around 30's count. This cotton is actually gives us 1800 CSP ok.

(Refer Slide Time: 53:23)



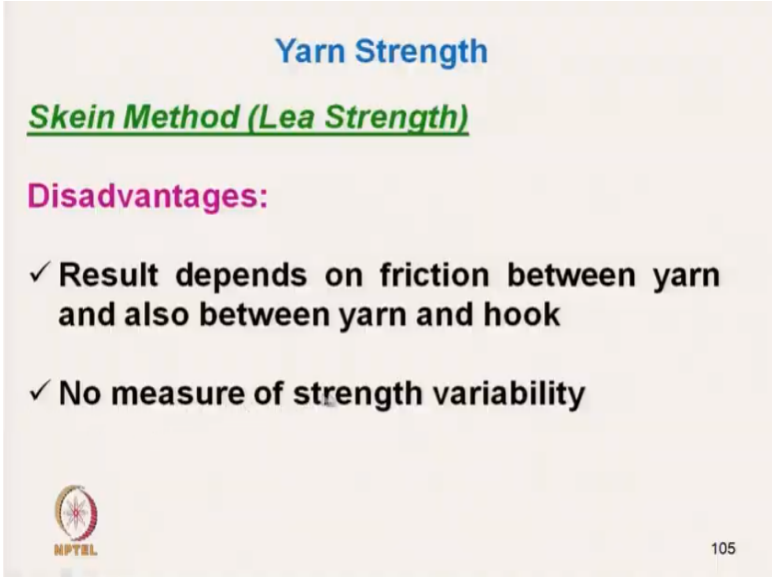
Now we are using another superior variety of cotton very high variety of cotton superior variety V2 which gives CSP of say 2400 CSP which is meant for 80's count, around 80's count. This 80's count yarn is there then this variety of cotton is meant for 80's count, if we produce then it will see; it will require a 30's count approximately 30 pound lea strength will give and we can 2400. Now suppose we are trying to produce very coarse count of this variety. From this variety we are trying to produce say 10's count, iin that 10's count can we expect strength of 240, 240 strength will not be there, it will be lower than that.

That means there is something wrong or selection of cotton is wrong. CSP also is very simple term but it talk's about too many things. So, it gives the indication of variety of cotton like when we are going to purchase a cotton, they will tell ok this I will give as CSP of 1800 CSP, you know that you have a quality and this yarn is in range of around 30's count, this cotton is for 30's count and if that particular cotton everything is right with the cotton if you still not getting 1800 CSP. That means your machine there is measure problem is there ok.

That means that it also gives the optimum count possible it will gives us the idea about the machine performance. It will give us the idea about range of cotton it produced, it will gives idea about range of count we can produce, it will give you idea about whether over spinning it, under spinning all this idea it will give. So, that is why, it is approximately constant for particular variety of cotton it is not the unique value, if you change the variety it can range from say from maybe 1000 or 800 CSP to 3000 CSP.

And if it is asked that yarn we are getting 800 CSP another yarn we getting say CSP of say 2000 which is having with a better cotton that means definitely 1000 CSP is better cotton ok. But for better cotton if you try to produce coarser count as we have seen it is not giving the higher CSP. So, CSP value indicates the overall performance of the spinning machine ok.

(Refer Slide Time: 58:14)



Main disadvantage of the technique is result depends on the friction between yarn and also between yarn and hook. So, if the yarn to yarn friction is changed keeping the yarn same if the yarn to yarn friction changes then the yarn CSP will change that is the very common example and normal cotton yarn if we take and the same cotton yarn if it is covered the lea strength and the CSP value, the lea strength value will be changed ok that is the;

So, the CSP is normally taken in the raw form, raw cotton form and measure of strength variability, so strength variability we do not know we get the overall strength value and we till stop here in next class we will start the fabric tensile test ok with the strip tensile test till then, thank you.