Science and Technology of Weft and Warp Knitting
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Module - 6
Lecture - 25
Knitting Calculation - Yarn Selection

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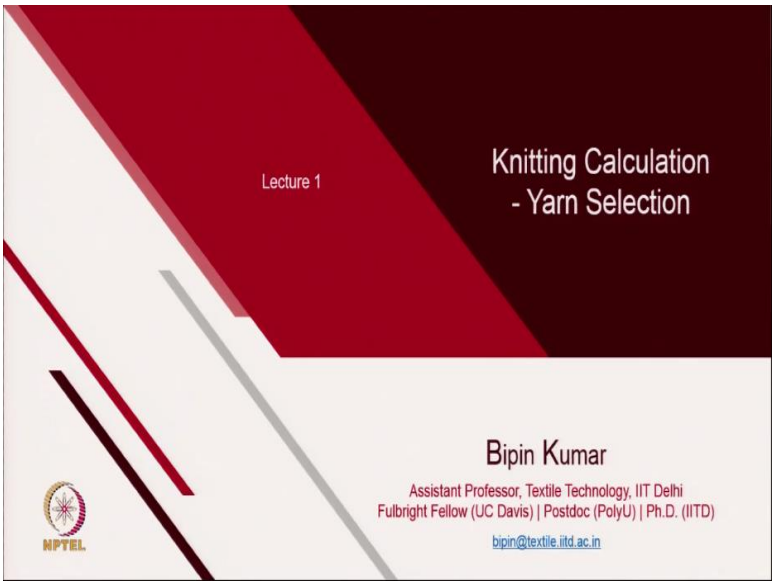

Welcome participants, to this particular week. In this week, we will be mostly focusing on all calculations related to knitting. In last weeks, you have seen lot of technologies related to weft knitting, including single bed knitting, double bed knitting, circular knitting, flat knitting. We have also seen that fabric designing, you designed a number of fabrics. You have seen jacquard knitting, where you have the possibility of loop transfer, racking.

So, with the help of that, we can design enormous number of fabric structures. Now, let's focus here completely on some of the basic structure for which we can derive some useful relationships through which we can calculate or determine yarn parameters which is required for knitting. Or, we can determine the fabric analysis with the help of these equations. Or, we can determine the production of the machines. So, in this entire week, we will be mainly focusing on deriving some useful relationship from yarn or fabric parameters, as well as machine parameters.

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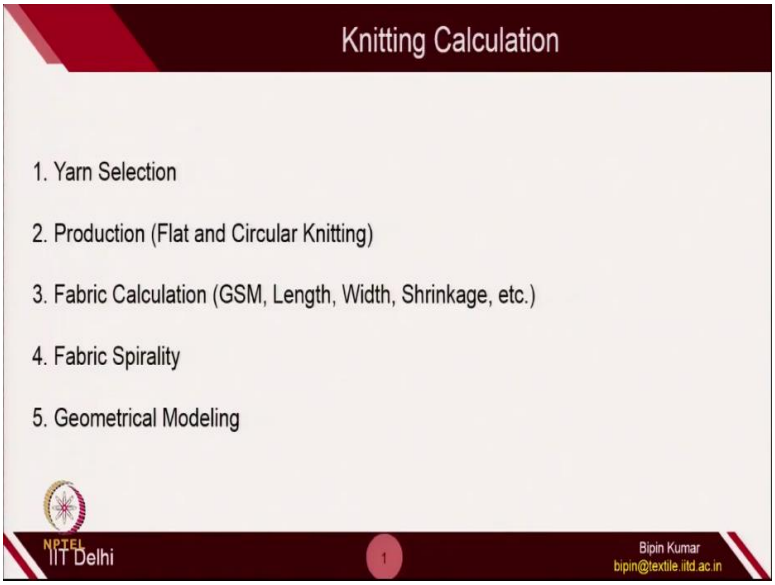

So, let's start calculation part. So, in this particular category, I have divided the knitting calculation into 5 segments. So, first we will talk about the yarn selections. Yarn selections means, you have seen the machine gauge varies, machine technologies varies; so, we cannot run the same type of yarn in all the machine gauge or all the machine technology. So, definitely we need to choose the right yarn or right yarn count for a particular machine technologies and gauge.

So, what are the relationship that exist between the yarn count and the machine gauge. That, we are going to look at in this particular lecture. Second thing, we are going to also learn about the production. Because, if you see from the company point of view, they are more worried about how much you can produce; how much length of the fabric can be produced in a hour; or what are the weight of the fabric that can be produced in an hour.

So, the company are more focused on the production rate. So, we will see how we can use machine parameters and structural parameters to determine the fabric production both on flat as well as circular knitting. Now, we will also see some of the basic calculations related to a fabric, like calculating GSM with fabric structural parameters, like loop length, stitch density, yarn tex.

We will also see length and width of the fabric, how we can determine with the help of shrinkage parameters. So, all related to calculations of the fabric structure, we will derive some useful relationship. The fourth part is fabric spirality, which is also very commonly

observed in single jersey fabric on circular knitting, especially multi-feeder circular knitting machines. We observe spirality.

So, this is a new term to you. Spirality is nothing but, you will observe the wale line will not remain vertical. And you will observe the structure of the fabric in a relaxed state. The course line or the wale line will not be perpendicular to each other. So, in that case, some defects may be observed in the fabric appearance. So, we will see how a useful relationship can be help you to removing this spirality defect from the fabric.

So, once we will move to that lecture. Other also, some geometrical modeling, like how you can derive GSM, cover factor, everything with by loop length. So, these are the, some topics which we will be covering in this particular week. Let's start with the first topic, which is selection of the yarn. So, how do we select yarn for a particular machine or for a particular machine gauge?

So, since yarn is the key word here, so, first we will learn some basics about yarn and then we will move, what are the criteria and what are the relationship that exist for yarn selection on a particular machine.

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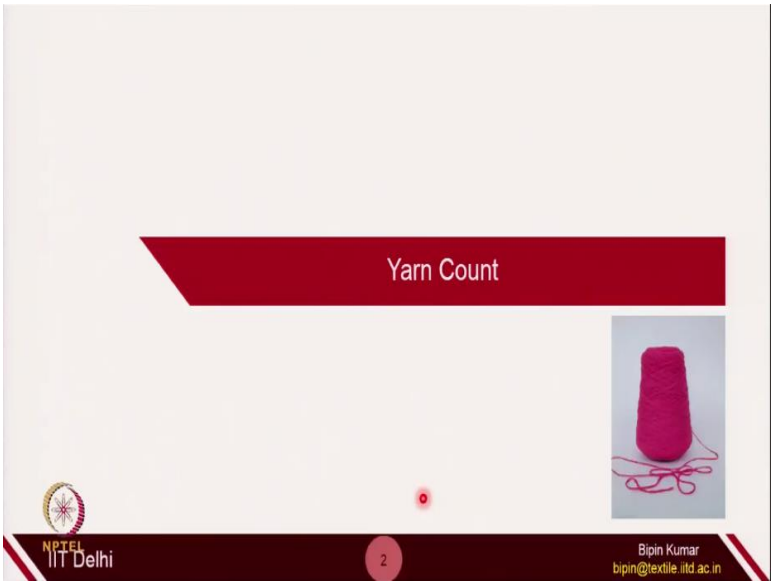

So, first thing we need to understand is yarn count. I know many of you who have done courses related to textile, they might be knowing this word count. So, count is nothing but, we determine the linear density of the yarn. So, it's a way to represent the mass per unit length of the yarn.

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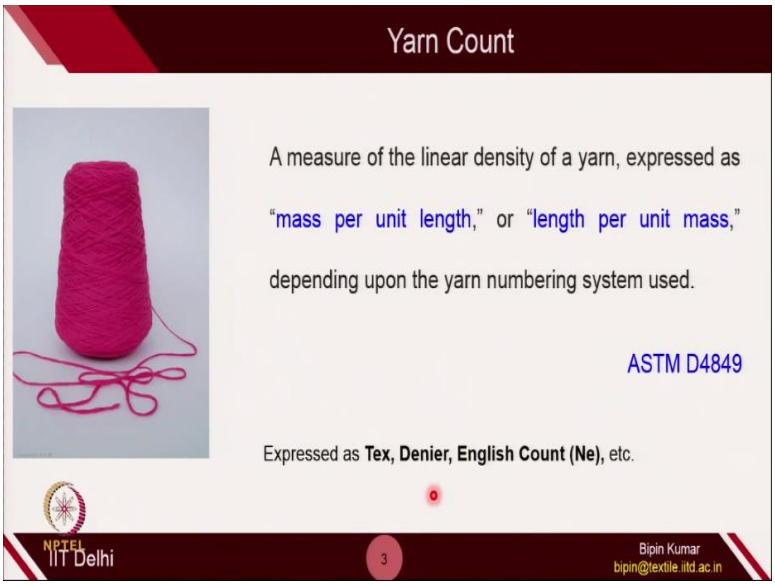

In terms of standards, if you see yarn counts, there are n number of yarns you can find in textile industry, either cotton yarn, polyester yarn. And all of these can vary in terms of yarn count. So, yarn count is nothing but a kind of linear density, which is expressed as either mass per unit length or length per unit mass, depending on what are the yarn numbering system we used. So, some of the common terms in which you might have heard in yarn count is tex, denier, English count, metric count, worsted count.

So, it is better to clarify these terms. Because we, I will be also using some of these terms frequently. So, let's clarify these few common terms which is used in representing the yarn count.

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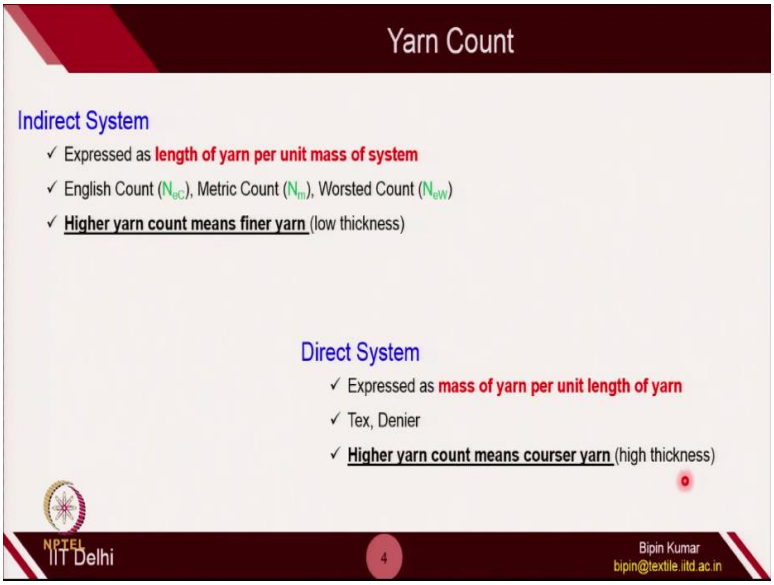

So, in yarn count, we basically follow two methods. First is indirect method, where we express the length of yarn per unit mass of the system. So, here, there are 3 commonly used yarn count system: English count, metric count and worsted count. And here, if you are expressing the yarn in terms of indirect system, it means, when you have higher yarn count, it means you are dealing with lower thickness yarn or finer yarn.

So, higher yarn count means finer yarn in case of indirect system. In direct system, it is the reverse. So, here we expressed the yarn mass per unit length of the yarn. So, here mass of yarn per unit length of the yarn. And here, 2 popular terms that we used is tex and denier. In, if we are talking or expressing yarn in direct system, it means higher yarn count means courser yarn. So, this is the common difference.

And, where, if you see indirect system, higher yarn count means finer yarn. But, if you see direct system, higher yarn count means courser yarns, higher thickness. So, it is better we should clarify this, because, so that you should be clear about whether you are following direct system or indirect system for representing yarn count.

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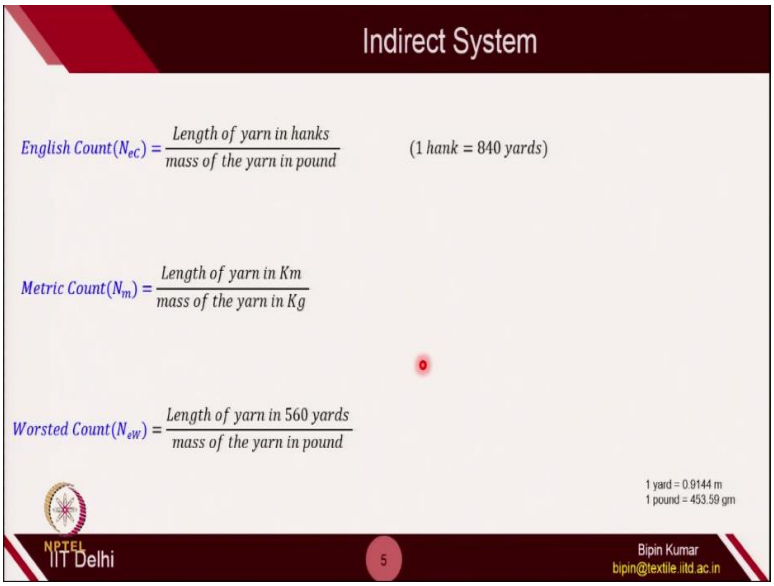

So, in the indirect system, the formula for finding the English count, which is the commonly used in western world, especially UK, USA, Australia. You will find English count is quite commonly used. It is the **length of the yarn in hanks/mass of the yarn in pounds**. So, if you take 1 pound weight of the yarn; you just measure it lengths in hanks. And 1 hank is 840 yards.

So, there are lot of conversion you need to learn. So, 1 yard is 0.9111 meter, and 1 pound is 453.59 grams. So, these are some of the common conversion things which we use here. It depends on you, whichever you feel comfortable, you can follow any of these system. In metric count, it is described as **length of yarn in kilo meter/mass of yarn in Kg**. So, you take 1 Kg of yarn and you measure the length in kilo meter.

In worsted count, you take the 1 pound of yarn and measure its length in 560 yards. So, if you see here, in all of these parameters, the weight is coming in denominator and the length is coming in numerator. So, it is a indirect system, where you measure the length per unit weight. So, you keep the weight constant and you just measure the length.

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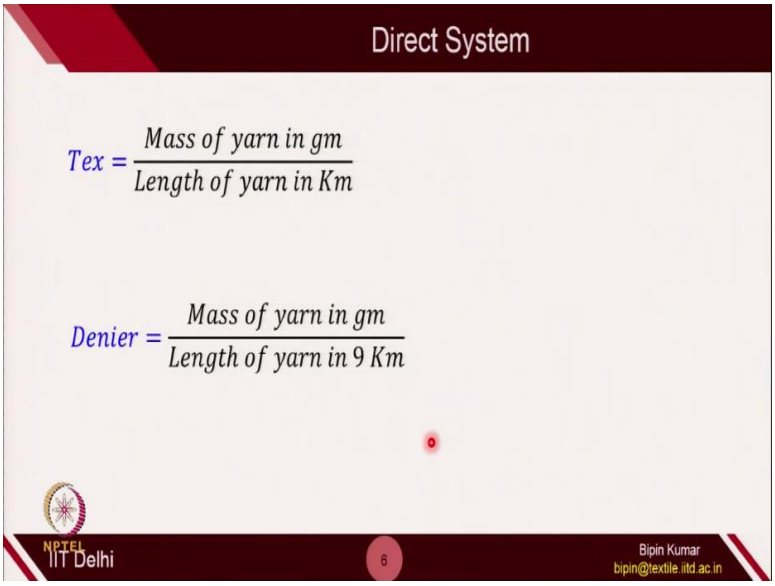

In direct system, this is more direct. So, you will just take the common length of the yarn and you measure the mass. So, tex is described as mass of yarn in gram and length of yarn in kilometer. So, you take 1 kilometer of the yarn and you measure its weight; that is the tex value. In case of denier, you take the mass of yarn in gram, length of yarn in 9 kilometers. So, these are the direct system.

You can, anytime you can switch from direct to indirect system. Because, if you know the mass, you know the length. It just ratio of these 2 terms. So, if you know any of these 2 values, you can go from direct to indirect system.

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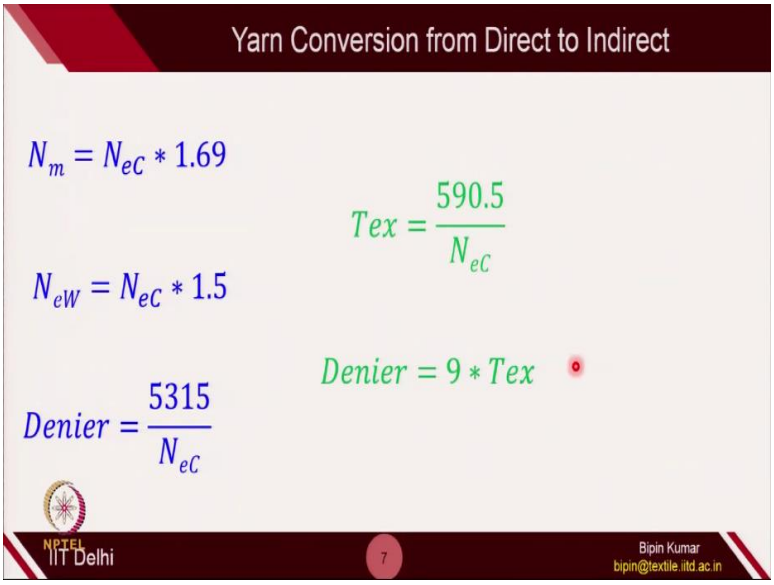

Or you can follow some of these formulas to directly convert from direct to indirect. So, for example, here metric count is connected with English count. So, NeC is the **English count * 1.69.** So, if your yarn count is given in metric form, then you can simply multiply 1.69. Worsted count, English worsted count is connected with English cotton count is into 1.5. **N_{ew}=N_{eC}*1.5** So, English count and worsted count is connected by this relation.

If you want to relate direct and indirect. So, **Denier = 5315/ N_{eC}**. **Tex= 590.5 / N_{eC}**. And denier is related with tex by these formula. So, you can see how the, how these useful relations; it has so important that, you can anytime switch from direct to indirect systems. So, depending on whichever country you are going or you are dealing on the count system. So, you can remember these formulas and convert these counts from one system to another system.

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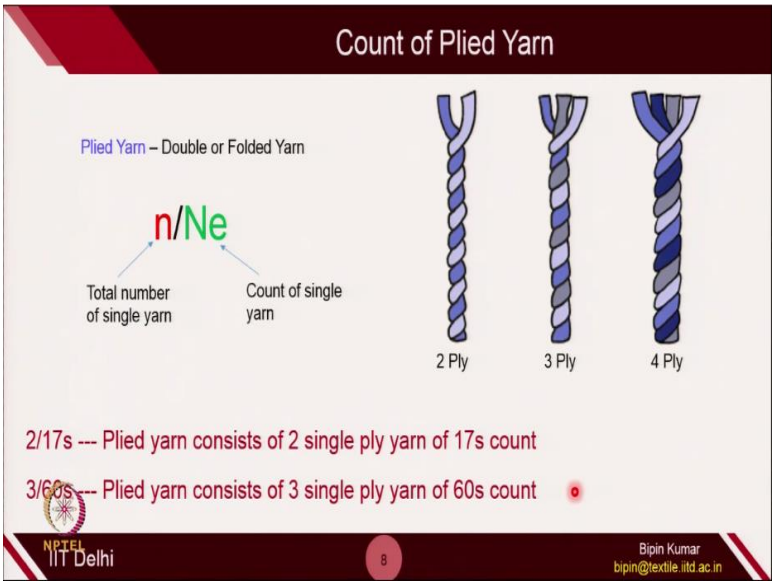

We have also count of plied yarn, which is quite useful, especially if you see sewing yarn and even in knitting yarn also; sometimes we use 2 ply, 3 ply or 4 ply system. Plied yarn is actually double or folded yarn. So, when you take 2 yarns and if you twist together, then you can generate 2 ply, 3 ply and 4 ply, depending on how many yarns you are twisting. Plied yarn actually denoted by this way.

The first alphabet is representing how many number of yarns you are twisting and the second alphabet which is representing the count of single yarn. So, for example, 2 / 17s. It is actually showing a plied yarn consisting of 2 single ply. So, 2 indicates 2 ply are twisted. And each yarn has 17s counts. So, s is actually indication for English Count. 17 s, it means 17 Ne. So, this is, s is useful for denoting the English count.

So, if you see **3 / 60**. So, here you can see, plied yarn consist of 3 single ply. So, 3 it means 3 ply, 3 yarns are twisted. And each yarn has 60s count. So, each yarn has 60 Ne. So, this is how you represent the plied yarn. So, I have couple of examples to do practice, from conversion from one to another. Let's do 1 or 2 simple examples, so that you can get used to of this conversion.

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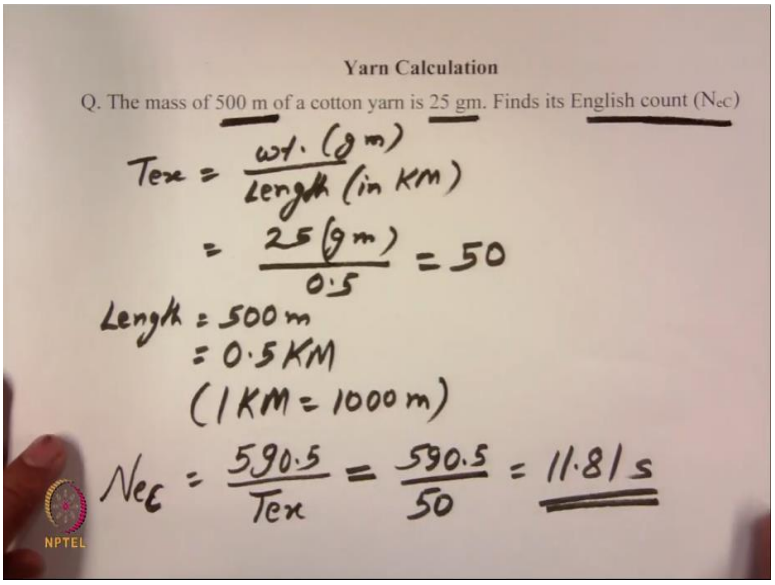

For example, let's see simple question. For example, the mass of 500 meter of cotton yarn is 25 gram. Find its English count. So, you have to find the English count. And weight and length is given. So, if you remember, the formula for tex; **tex = weight (gm) / length in kilometer**. Okay. So, what is the weight? 25 gram. So, this is in gram; 25 gram. And what is the length in kilometer?

So, length is 500 meter. **Length = 500 meter**. So, in kilometer, we can express this 0.5 kilometer. So, if you know, **1 kilometer = 1000 meters**. So, you can simply convert this. So, in tex, you can in length you can put here 0.5. So, the tex value will be 50. So, **tex = 50,** length is equals to 0.5 meter. So, you simply take the ratios of these 2 quantity; and you will get the tex. Now, let's see English count.

So, how you will find the English count? So, we have seen the formulas for correlating English count and tex. So, **NeC = 590.5 / tex**. So, this is the formula, you can go and cross check the slides. So, **NeC = 590.5 / tex**. And what is the value of tex? 50. So, **590.5/50=11.81s.** So, we will simply get **11.81**. So, English count is generally represented by s. So, 11.81 count. So, considering this value of mass and length, we can found the English count.

So, this is the count. So, we generally in normal terms, we express this linear density of yarn in either count or tex form. So, you can follow up any one, whichever you find suitable. Let's go for the other question. Again, it is the simple one.

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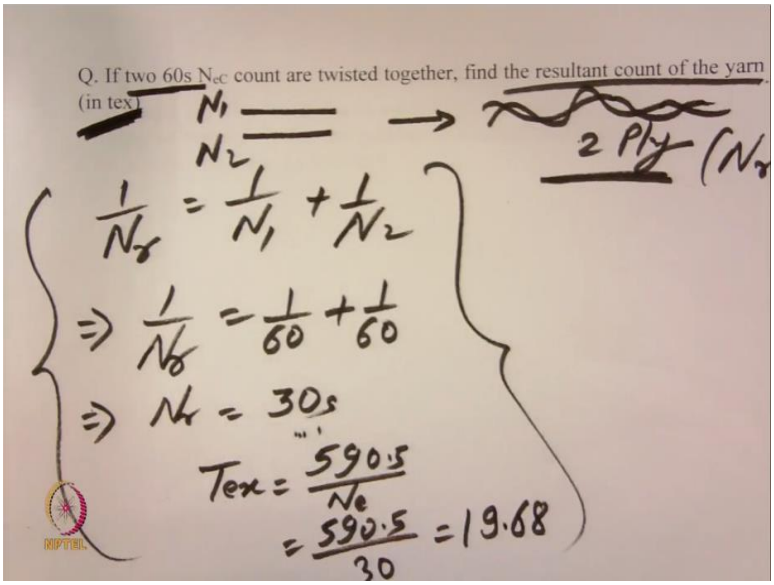

If two 60s count are twisted together, find the resultant count of yarn. So, basically you have 2 yarn. And you combine these 2 yarn and twisted together. So, basically you are making 2 ply yarn. Okay. So, you combine these 2 yarns and you twisted together. So, you have 2 ply yarn. You have to find out the resultant count. So, you can use direct formula. There are so many formulas in textile books, where you can directly from the English count you can directly use the formula and get the count for resultant yarn.

So, the formula, if you will find. So, **1/Nr (resultant) = (1 / N1) + (1 / N 2)**. So, N1, N2 is the count of individual yarns. So, this is Nr resultant yarn. So, the count of resultant yarn. This is N1, this is N2. So, since both the yarns are same, so **(1 / 60) + (1 / 60).** So, you can simply get **Nr = 30**, 30s count. Okay. Now, it is asking the resultant count in tex. So, you can see, we have to convert this Nr into tex. So, **tex = 590.5 / Ne**.

So, **590.5 / Ne**, Ne which is 30. So, this is equal to 19.68. Okay. So, this is how you can use the conversion formula. So, it's very, very useful and I expect you to learn some of these commonly used terms. Now, let's move to the other part in yarn segments. So, the other thing which is important in yarn is twist.

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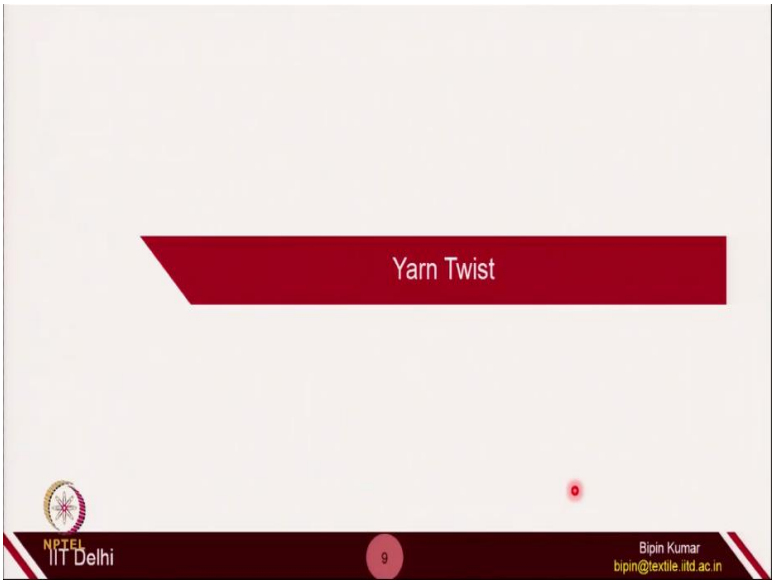

So, if you have seen, most of the yarn which is used in knitting are either spun yarn or filament yarn. And to make the yarn from the fiber, we use twist. So, we usually twist the yarn.

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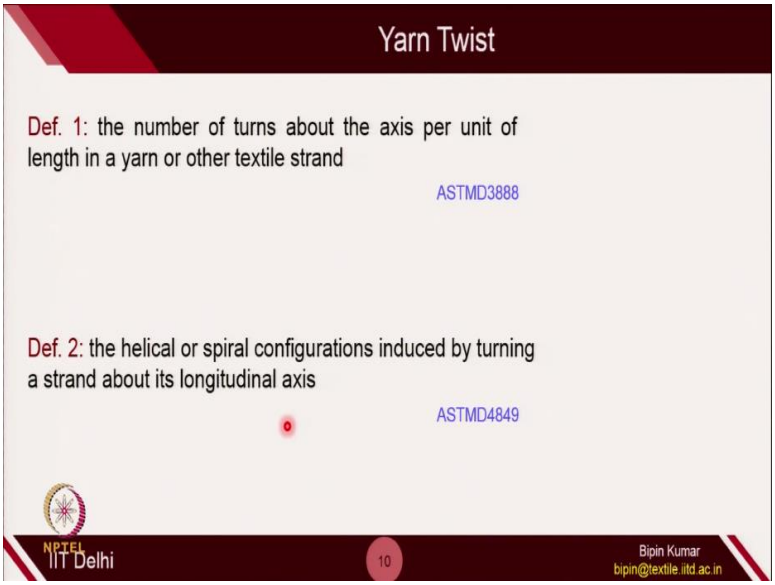

So, twist; if you see the definition of twist as per standards, it is the number of terms about the axis per unit length of the yarn or other textile strands. So, if you take a bunch of fibers and if you try to start turning those fibers along the yarn axis, that is called twist. It is expressed number of turns per unit length. So, the other thing is the helical or spirical configuration induced by turning a strand about its longitudinal axis.

This is again a very common terms used in textile industry. So, twist is also very, very important apart from count. Because, if you keep increasing the twist, it might be possible the yarn become very stiff or it may break. So, twist is also important.

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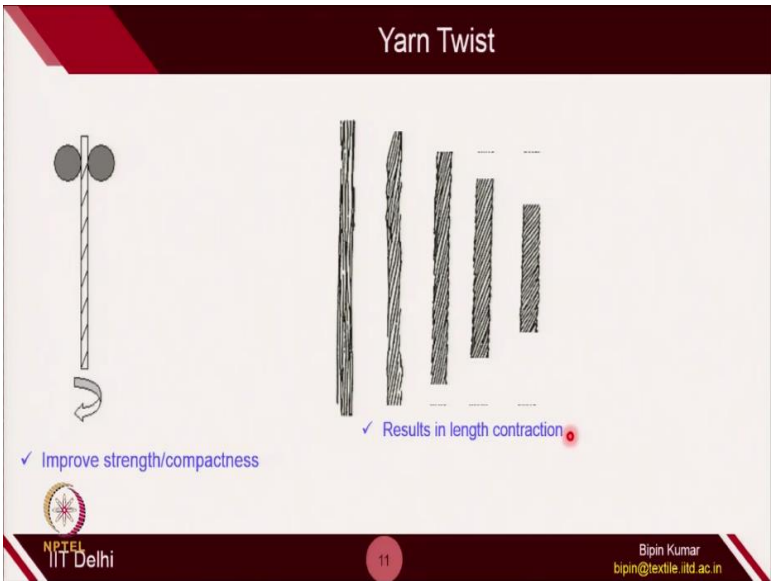

So, in reality, twist is used to improve the strength and compactness. But, too much twist or turning of the fibers should also be avoided. So, for the knitting point of view, twist is extremely important. Because, if you use highly twisted yarn, there might be possibility that it may not bend properly and the loop geometry will be distorted. So, twist as well as count is extremely critical and it should be in certain range, so that it can run smoothly on the machine.

So, you can see here, in usually, this is the parallel strand of fibers. And the moment you start turning it, the fibers start in the, arranging in a spiral form and the length of the yarn will also reduce. So, this is how the yarn twist influence the yarn properties. It makes the yarn little bit stiffer. And it will also result in shrinkage. So, the length of the yarn will also contract along yarn axis.

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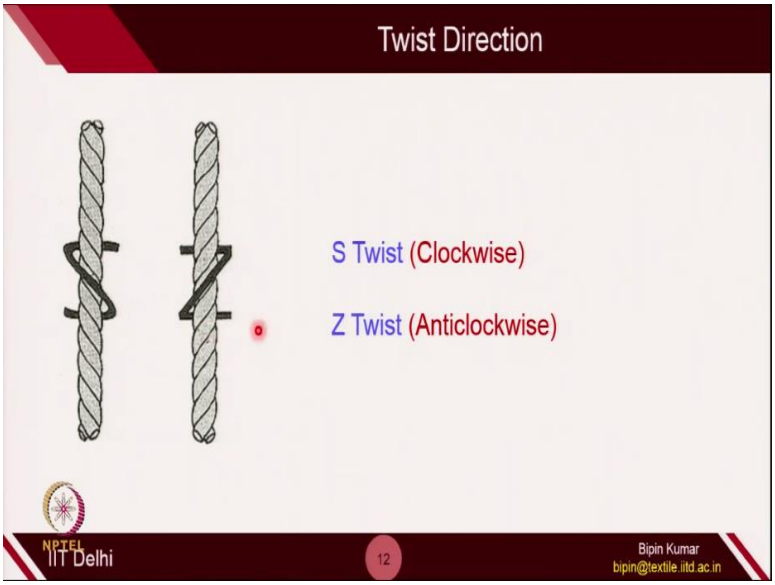

So, in twist, there are 2 terms which is quite commonly used. So, you should also be careful about the kind of twist which is imparted to the yarn, whether it is S-twisted. So, if you see here, here the nature of spirality is along the S direction. So, this looks like S. So, if the yarn is twisted in clockwise fashion, this is S-twisted. And if the yarn is twisted in anti-clockwise fashion, this is the anti-clockwise fashion;

So, you can see, it, the spirality become reverse. It looks like a Z-twist yarn. So, sometimes we have seen like, the kind of S-twist yarn or Z-twist yarn you use on the machine, it can have significant influence on the fabric properties. So, in fabric spirality, when I will talk about after few lectures in this week, you will realize how important is to play with these 2 different twist direction. So, not only the count, but also the twist amount and twist direction are extremely important from knitting point of view.

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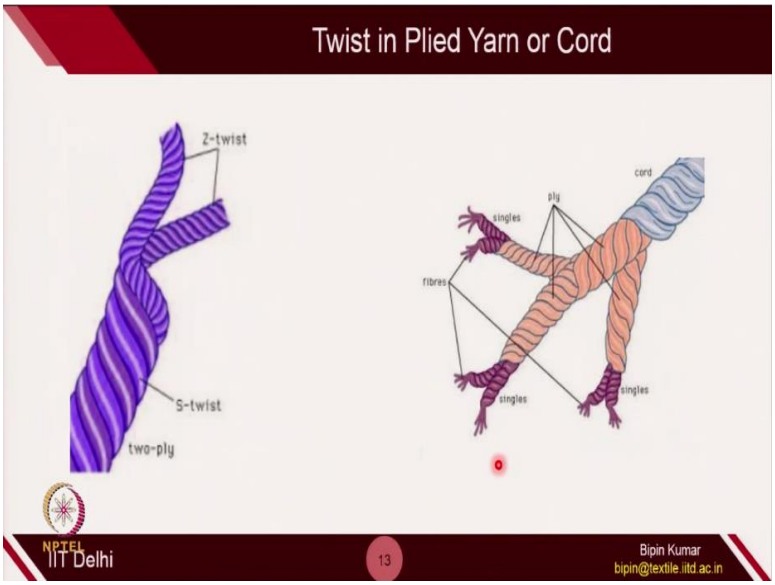

Twist of plied yarn or cord yarn. So, you have seen the plied yarn where 2 or more yarns are twisted together. Sometimes, it might be possible that you can twist 2 plied yarn. So, you can see here, this yarn itself is a plied yarn. And when you are twisting plied yarn to make cord; this is called twist in plied yarn.

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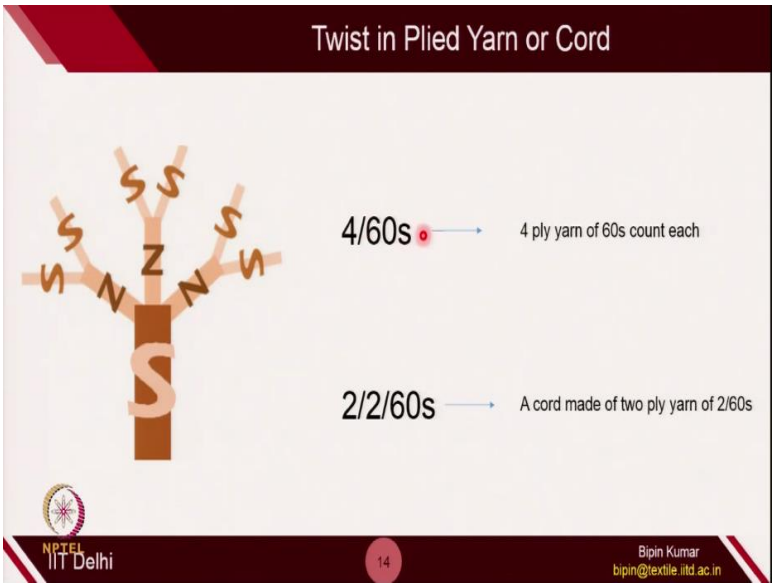

So, in twist in plied yarn; so, the twist which has to be imparted, it must be, the direction must be the opposite of initial twist. So, whenever you have, let's suppose, here you have S-twisted plied yarn. Then, when you are combining these is equals to twisted plied yarn, we need to apply Z-twist. And when you are combining Z-twisted plied yarn, then we have to impart S-twist direction. So, this is again some common things which is found in textile yarns.

So, for example, here, if you have 4/60s. So, it indicates, 4 ply yarn of 60s count each. So, 4 indicates the number of single ply yarn. And 60 indicates the count. When you have 2 bar; so, it indicates; 2 indicates, you are combining two 2 ply yarns. So, 2 by 60. So, 2 by 60 is, you are combining 2 single yarn to make 2 ply yarn. And then you are taking that 2 ply yarn to make a cord by giving different twists.

So, a cord made by 2 ply yarn of 2/60s. So, 2/60s, again you can describe with using like this. So, 2/60s means, you have 60s count and you are combining 2 yarn to make 2 ply yarn. And then, you have taken two 2 ply yarn and you have combined them together. So, twist is extremely important from fabric point of view.

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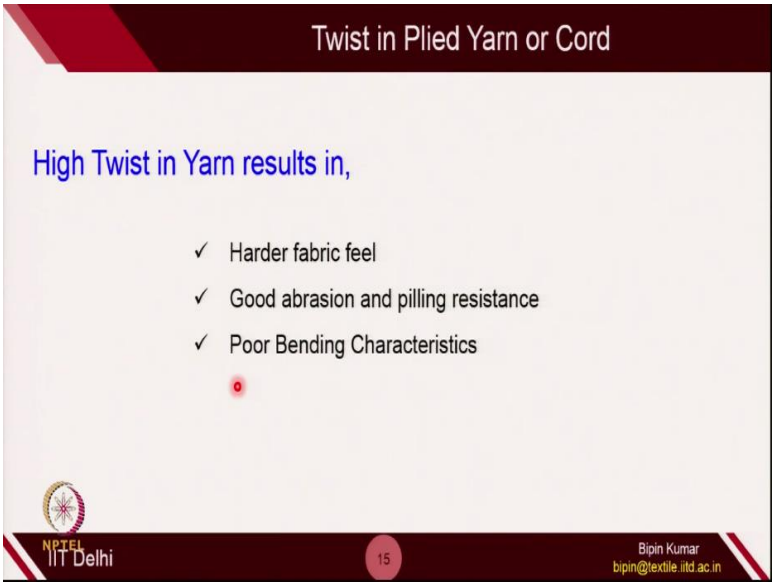

High twist, if you use, you will feel the fabric is little bit harder. It will result in good abrasion and pilling resistance, but unfortunately, it has poor bending characteristics. So, you will realize, when you are dealing with very high twisted yarn in knitting. And in knitting, bending of the yarn is the first criteria. Because, the, if you see the needle movement, it is actually catching the yarn and bending it.

So, bending by default is one of the key requirement which should be smooth in the yarn. So, if the yarn is extremely stiff, it will not bend it properly. So, you, there may be chances of needle breakages or there may be problem in loop formation. So, that's why, poor bending is not recommended. Yarn having poor bending characteristics is not used in knitting. Yarn should be good enough to bend properly.

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Now, let's come to the topic. You have seen these two commonly used parameters which expressed yarn, which is count and the other one is twist. Now, let's see, whenever we have a working on a particular knitting machine, how do we select yarn; what count we should used; what twist we should used. Especially, the count is extremely important. Because, on a particular machine, certain parameter is always fixed, like machine gauge and the technologies, whether it is flat bed or circular bed, something is fixed on the machine.

So, what are the right yarn count that should be selected. So, this is the thing which we are going to see in couple of slides. So, some of the very commonly features which is used in knitting from the yarn point of view, that yarn should be smooth.

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Especially, if the yarn is very, very rough, then you can have the problem of abrasion with the yarn needles or the trick, the trick on the bed. And there, because of that, the fly can generate. So, smoother yarn is better, because it will keep watch in the fabric formation and less fly will generate. And also, the friction will be less. So, there is less rubbing of the machine parts. Yarn should be sufficiently strong.

Because simultaneously, so many needles are catching the yarn and pulling it strongly towards the bed, inside the trick. So, if yarn is not strong, it might break very easily. So, a sufficient strong yarn is the prime importance for knitting. Good elastic recovery: Because you have seen the yarn is always in extension mode on the machine. So, the yarn should recover well, otherwise, you will get extended fabric or distorted fabric.

Also, the count. Because, we can have different diameters of the yarn, for, because the yarn count can vary depending on the yarn spinning parameters. So, what are the right count that is suitable for the machine, it will depend on the machine gauge and the technologies which you are using. So, in this, we are actually focusing the relationship which can be used for selecting the yarn count for a particular machine. So, count is again very important.

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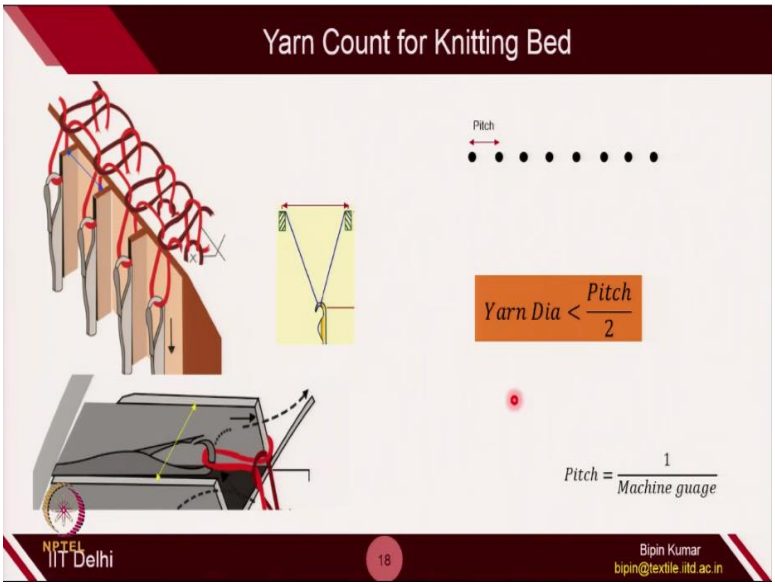

So, if you see the yarn count for a knitting bed. So, in a knitting bed, we have seen the tricks are there and the needle moves inside the trick by catching the yarn. So, you can see here, the needles is moving this wall inside the trick. So, trick is created by the trick walls. So, between two trick walls, the needles is moving. So, these are the trick walls. So, you can see this wedge. So, these represent the trick walls.

And the needle is catching the yarn and moving inside this slot which is the trick. So, if the yarn diameter is extremely thick, then there might be chances that the yarn can rub with the trick wall. And in that case, the knitting will be disturbed. So, depending on the pitch, which is the distance between two needles or you can say which is the distance between 2 trick wall. It is important that, whenever needle it is catching the yarn, the diameter of yarn should not be more than the half of the pitch.

Because, if the diameter of the yarn, if this yarn is greater than half of pitch distance, then there might be problem with catching the yarn and pulling it inside the slot. So, yarn diameter should must be **< pitch / 2**. So, **pitch = 1/machine gauge**. So, if you have the machine gauge, you can relate machine **pitch = 1/machine gauge**. So, the maximum yarn diameter which you can used on a particular machine is no doubt connected with the machine pitch or the machine gauge.

So, in reality, if you know the yarn diameter, the maximum yarn diameter which you can use is, should be less than half of the pitch. So, if you are below this, that is good enough. If the yarn diameter is very, very thin, then there will also be a problem, because it may break easily, because the needle will be resulting in very harsh action on the very thin yarn. So, we cannot have much thicker yarn and also we cannot have much thinner yarn. So, we have to be carefully playing in a certain range, so that a particular yarn can run smoothly on that machine.

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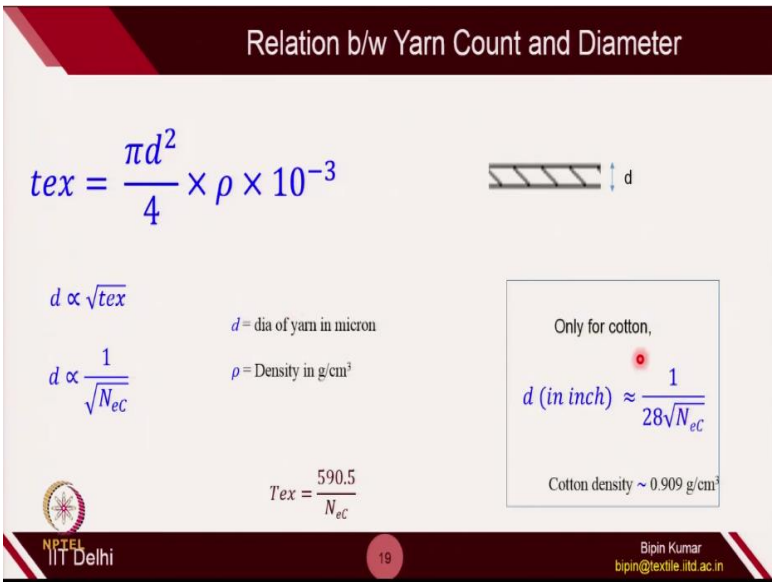

So, if you see the tex and diameter. So, here you have seen, the yarn diameter is connected with pitch. And yarn diameter is directly related with the yarn count. So, here is the relation. So, if you know the density of yarn and diameter of the yarn. So, this is the diameter of the yarn. So, **tex = $\pi(d^2/4)*\rho * 10^{-3}$**. So naturally, if you see, d is related with tex.

So, if d is related with tex, so tex is related with machine gauge. So, you can guess like count and gauge are somehow related. So d, if you see, **d α $(tex)^{1/2}$.** And from the conversion formula, you know **tex α 1/NeC**. So, **tex = 590.5/NeC**. So, English count and tex are connected with this formula. So, the diameter of yarn is related with yarn count. Diameter is actually deciding the selection, because this diameter should be less than half of machine pitch.

So, again, if you see very commonly used for cotton, the diameter, the direct relation is **$1/(28(NeC)^{1/2})$**. So, **diameter α 1/NeC**. And here, the constant is 1/28, if you want to relate diameter and count. So, this is only applicable for cotton. For polyester, for nylon, for wool, this constant might be different. But, the key take from this slide is, diameter is no doubt connected with count of the yarn.

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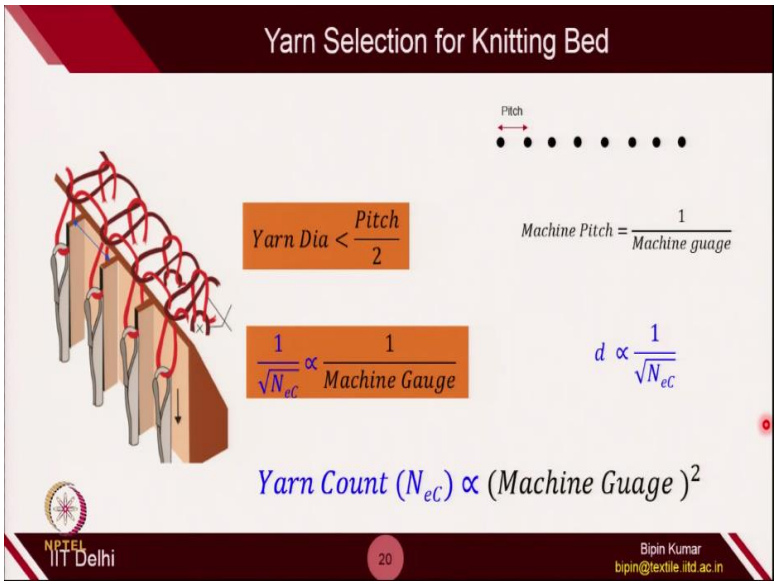

So, here you have seen, diameter is connected with the pitch, because you cannot have yarn diameter more than half of the pitch. Because, that's not possible, that's not physically possible. Because, at least 2 times the yarn diameter, the needle is catching. So, that much diameter or space is there inside this trick. Okay. So, since the diameter is related with yarn count, **1/NeC**, you have seen in previous slide.

And machine pitch is related with **1/machine gauge**. So, if you replace yarn diameter with English count and if you replace pitch by machine gauge; so, this is the relation you will get. So, **NeC α (machine gauge)^2**. So, again, after certain rearrangement, you will find,
NeC α (machine gauge)^2. So, this is some relationship which exist.

So, to derive what count is suitable for a particular machine gauge, it comes naturally by the experience. But the science is, you can see here. So, based on trying different counts on a particular machines, the observer has realized this, there is certain constant which you can used to relate count and machine gauge for different technologies.

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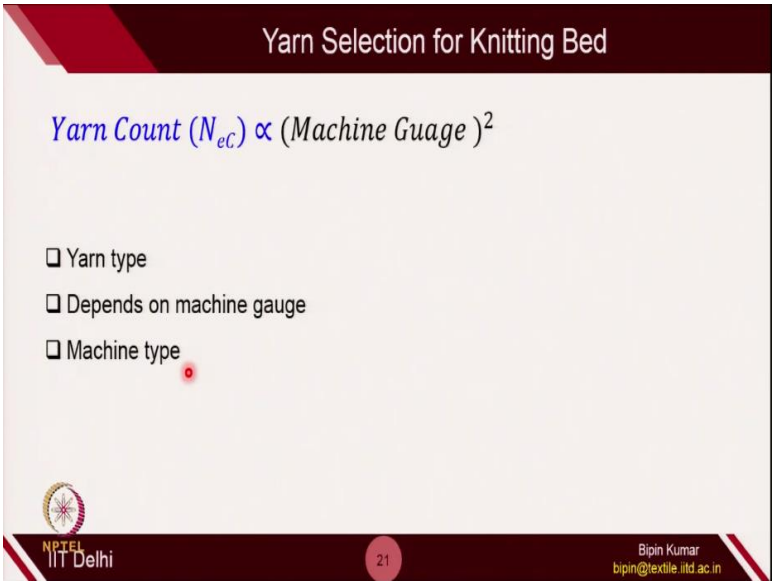

So here, for selecting yarn count for a particular machine gauge, it depends on the yarn type, machine gauge and the machine, what machine we are using, whether it is a single jersey or double jersey machine; whether it is a circular machine or whether it is a rib machine. So, for each of these, again, lot of hit and trials has to be done. And in last 50, 60 years, a number of knitters has been doing this exercise. And they have come up with some useful relationship of connecting count and gauge for different machines.

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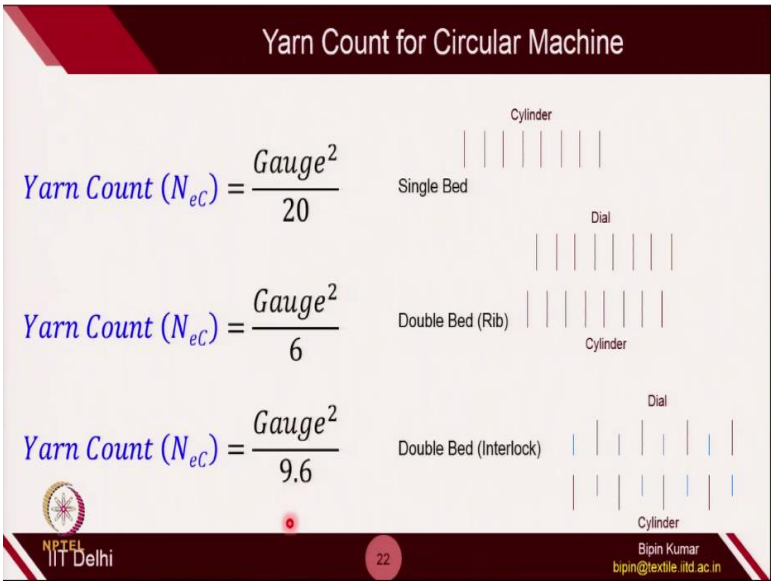

So, here for circular machine, here are some of the useful relationship. So, for single bed, when you have only cylinder, no dial, then the **yarn count = gauge^2/20**. In double bed, when the needles are in rib setting or rib gating, when you had cylinder and dial, then, the **yarn count = gauge^2/6.** Please remember, these yarn count is representing in English count.

When you see double bed interlock. Interlock, you might have seen in double jersey circular machine, interlock setting, where you have long butt and short butt needles placed alternatively. So, on this machine, the, based on the experience, they have used, they have found the constant is 1/9.6. So, for each machine type, you can definitely observe, this constant is changing. But one thing is common that, count is no doubt related with the gauge square.

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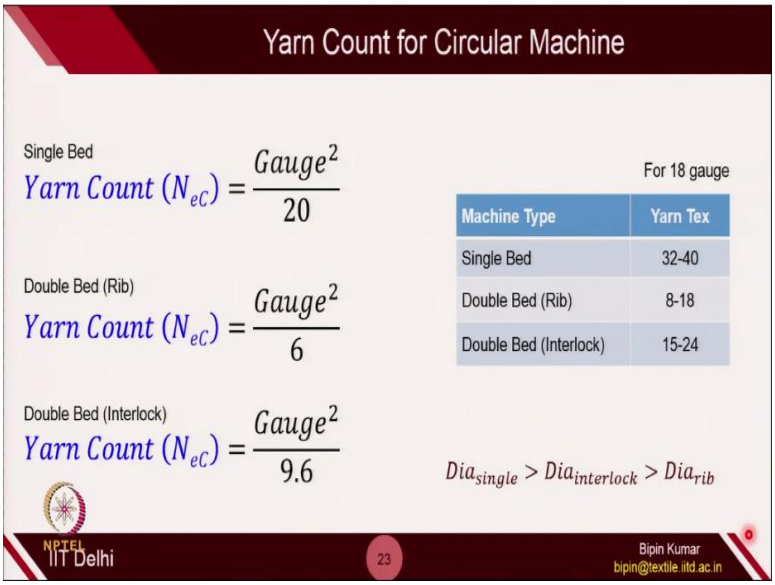

So, if you use this formula, and based on the knitting experience, this is some of the yarn count in tex, which is found suitable for single bed, double bed and double bed interlock and rib machines for 18 gauge. So, if you have 18 gauge, you can see single bed, you can use 32 to 40. So, the range is there, it is not hard and fast rule that you need to have exact same count. You can play ±4 depending on the machine technologies.

And it is again, this is a very empirical relationship. It has, this has derived from the experience. So, for single bed, you can play with 32 to 40. Double bed, the yarn tex which you can used is 8 to 18 for the same 18 gauge. So, for the double bed, please remember, 18 gauge is the gauge for both; on the cylinder, needles are placed 18 needles per inch, as well on dials, it is 18 needles per inch.

Rib, the yarn tex is lower. And in interlock machine, you can see, 15 to 24. So again, based on the machine type and the gauge, you can see, yarn count is different for different beds. If you connect tex with the diameter, you can easily found, higher tex means higher diameter. So naturally, on a single bed machine, you can play with higher diameter of the yarn. And on double bed interlock machine, again, the diameter should be less than the single bed, but more than the rib machines.

So, the, it is the rib where you must have to be very careful, because the possibilities of yarn count is less, especially in forms of tex. And you have to play with thinner yarn. So, this is some of the careful observations a knitter has observed after so many years of experience in knitting. Again, if you try to see why this constant are different.

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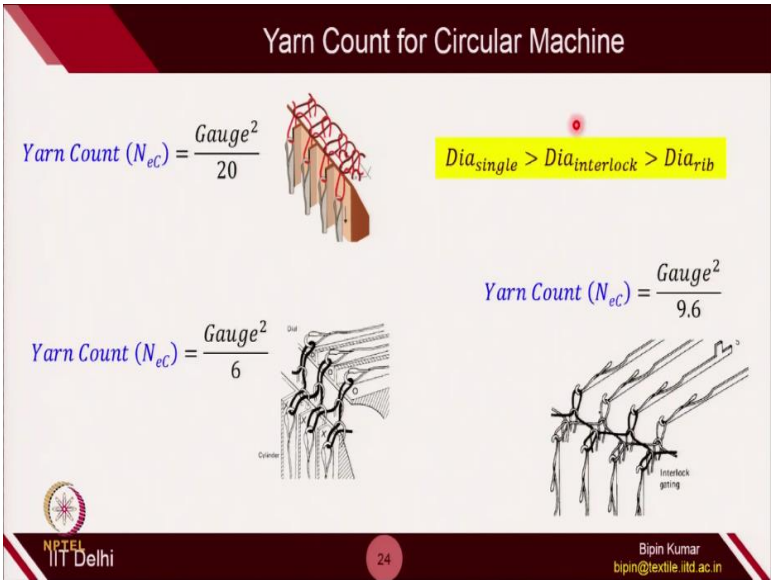

So, if you see single bed, there are lot of space available on the front side of the needle. So, that's why you can play with thicker yarn diameter. But if you see the rib; because of the placement of dial bed and the cylinder bed; so, there is limited space available in double bed machine. So, in, that's why, if you see rib machine and interlock machines, the yarn diameter will be always lesser than the yarn diameter that can be used on single bed machines.

Because, whenever we are making double jersey fabric, because of the presence of double bed, the available space for the knitting is will less. So, if you play with much thicker yarn here, there could be lot of rubbing of the yarn. So, there might be disturbance during knitting. So, single bed you can have higher diameter, but double bed, you can have lower diameters. But if you compare interlock and rib, this is the interlock and this is the rib.

So interlock, you have seen that, at a particular movement, only alternating needles of one bed is used. So, naturally, you have more space available. Because, you are not using all the needles in the same feed. You are not using all the needles in the same feed. So, in the first course, you are using alternating needles on both on cylinder and dial. So, in first feed, for example, if you are using long butt needles.

And then, in the next feed, you are only using short butt needles. So, sufficient space are there. So, that's why, you can have a higher diameter for interlock machine. If you go for flat machines;

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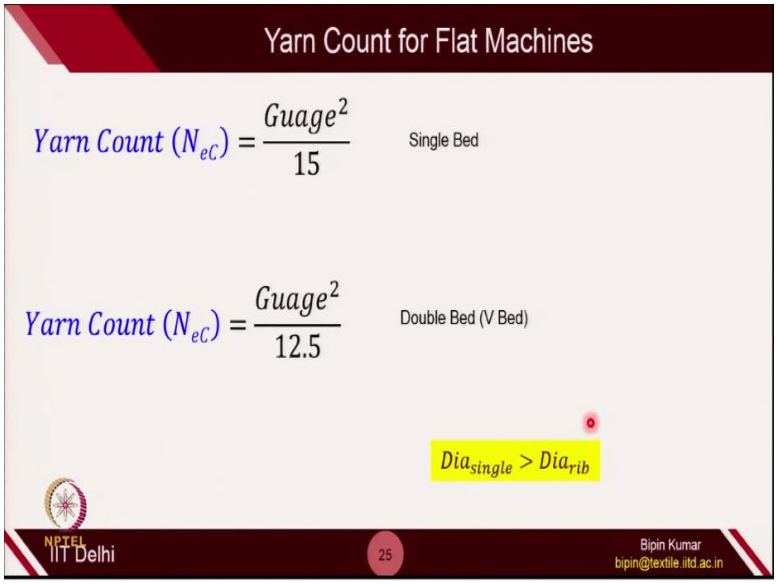

In single bed flat knitting machine, the relation is different **yarn count = gauge^2/15**. If you go for double bed flat knitting machine, relation is again different, **yarn count = gauge^2/12.5**. So, again, if you are moving from circular to flat, things are changing. And you need to be careful. And again, you do not derive these relationship, basically, it comes with experience of the knitter. So, this is, again, if you see here, the single jersey diameter is more than the rib machine. Again, this is because of the space available between 2 beds.

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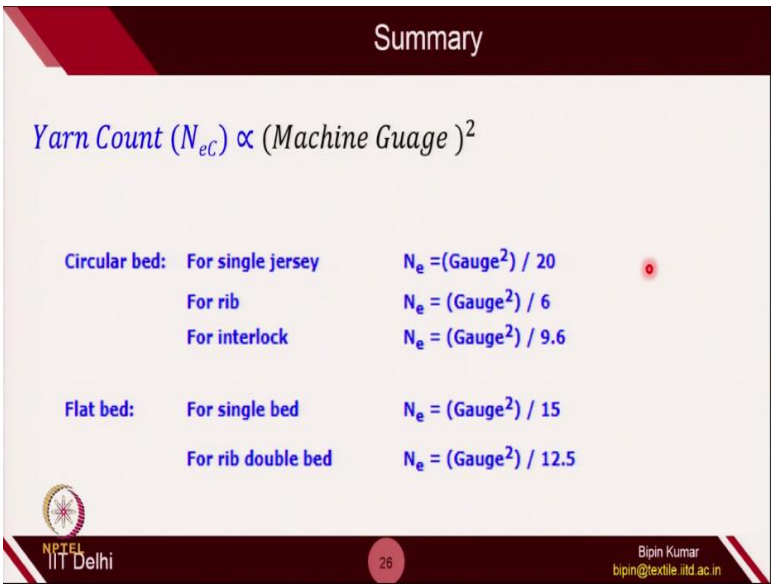

So, this is overall summary of, that yarn count is related with machine gauge square, but depends on the technologies that you are using. For single jersey, **yarn count = gauge^2/20**. In circular bed, for single jersey flat bed **yarn count = gauge^2/15**. If you see rib interlock and the constants are keep getting different. And this comes with experience. Let's do a simple

example, like how with the help of these relationship, we can select yarn that can be apt for particular machine. So, let's, I have a very simple examples. Let's see that example.

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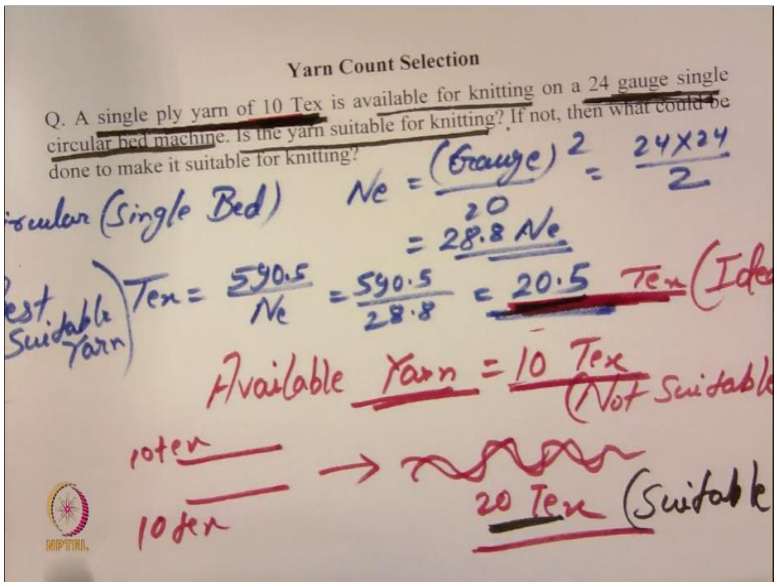

A single ply yarn of 10 tex; so, yarn count is given; is available for knitting on a 24 gauge single circular bed machine. Is the yarn suitable for knitting? So, the question is, can we run this yarn on the machine. So, based on the experience, we have seen, the relation of count and gauge. So, for circular single bed, the relation is **Ne = gauge^2/20**. So, the gauge is given.

So, as per, let's find out what are the best suitable yarn. So, this is **= 24 * 24 / 20.** 24 gauge; please remember, gauge is expressed as needles per inch. So, 24 needles/inch. So, if you solve this, the count will be 28.8 Ne. So, this is in English count. So, we can convert this into tex. **Tex = 590.5 / Ne = 590.5 / 28.8 = 20.5**.

So, best suitable yarn has the tex of this. Okay. And what is the available yarn? So, available yarn is, has 10 tex. Okay. So, you can see here, this is 20, this is 10. So naturally, this is much thinner yarn. So, available yarn in this form, we cannot run this machine, because this is much thinner yarn and the needle is courser. So, the moment if you start running this yarn, it is way below the expected tex.

So, it is always better to go for some processing on this yarn and increase its yarn count. So, the yarn is not suitable. So, this is not suitable, because it has much lower tex compared with the ideal one. So, this is ideal and not suitable. So, if not, then what could be done to make it

suitable for knitting. So, what process we can do is, we can definitely fit 10 tex. So, we can combine these yarn to make it 20 tex.

So, if you take 10 tex yarn, with the help of spinning, we can make the plying of these 2 yarns and make it 20 tex. So, we can combine. So, whatever yarn is present to us, we can take 2 bobbins of this yarn and we can make a double ply yarn. So, a double ply yarn will be having 20 tex. Now, this yarn is suitable in the machine. Suitable, because it has 20 tex; and you can see here, it is also 20 tex.

So, a single ply 10 tex is not suitable for, on a 24 gauge machine. But, if you make 2 ply of 10 tex, then it can be suitable. So, if you learn this formula, when you have the yarn with you, you can play around, you can at least guess before going on the machine itself what is the right combination of the yarn count that can run on this machine. So, this is very important from the practical point of view and I expect you to follow this.

So, with this, I am stopping this particular lecture. So, again, just a small summary. So, we have seen that how this small relationship is useful in selecting the right count for a particular machine. So, in next class, we will look some other relationship related to production, which is also very useful to in finding out how much fabric we can produce on the machine. This is also important from manufacturing point of view. So, with this, thank you very much and catch you in next class. Thank you.