Science and Technology of Weft and Warp Knitting
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Module - 6
Lecture - 30
Knitting Calculation - Fabric Spirality in Single Jersey (Tubular)

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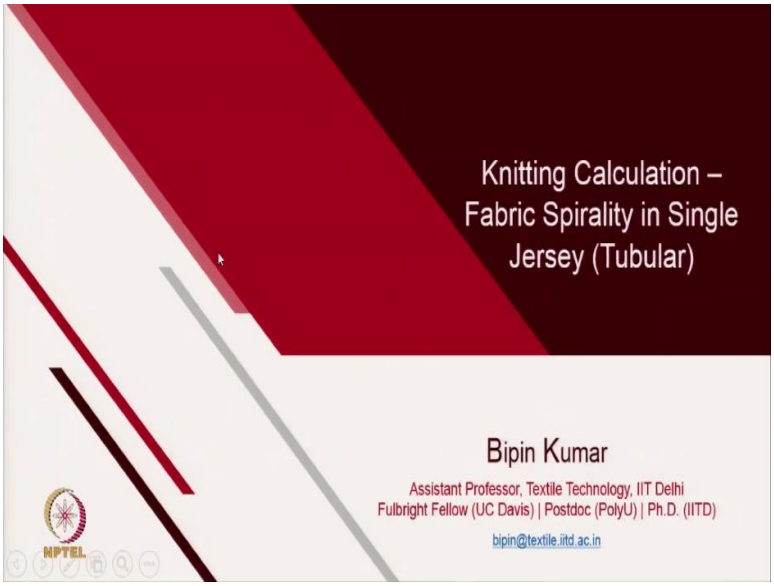

Welcome participants. Now, we are moving to the last section in knitting calculation. Today, the topic is fabric spirality in single jersey fabric. So, as I have already discussed in previous weeks that most of the fabric, we, which is useful in knitting is single jersey fabrics, so tubular fabrics, because they are very high productivity. So, from company point of view, production is very, very important.

So, majority of the fabric which is produced in weft knitted is single jersey fabrics. But, there is a big problem with single jersey fabric. One problem was curling which I already mentioned you in week number 2 and third. But there is a another problem which is very prominent in single jersey fabrics are fabric spirality. So, this spirality, I am going to cover. And I can define you some useful relationship.

And through this, you can able to control this problem and minimize this effect on the single jersey fabric. So, let's see, first try to understand what do you mean by spirality. So, this spirality is a big problem in single jersey fabrics;

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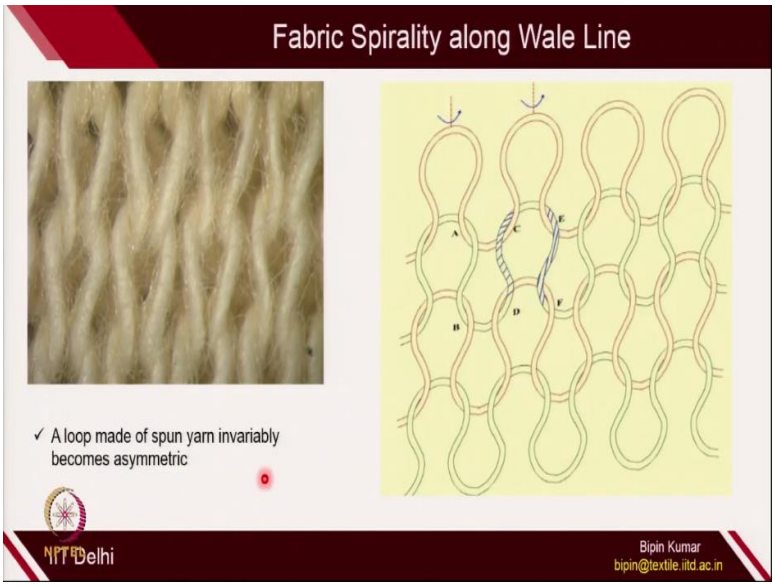

Where you will expect, the loops will not stay symmetric in the fabric structures. What do you mean by symmetric is, that when you make the fabric, take out from the machine, put it in a relaxed state; you will realize, these loops will not remain in perfect symmetric form. You can see, these loops are bent. So, the whole courses or the wales; you can see, the fabric has been spiral.

This is a big problem, especially with a spun yarn, where the wale and the course are not remain vertical or horizontal, which it was supposed to be there. So, courses will take the spiral form. So, you can see, each courses, it is making certain angle. Or if you see the wales also, the left side and the right side of the loop is not perfectly symmetrical. So, this is a big problem. Because, when you are playing with multiple colors of yarns; and if the color is not following certain pattern, then there could be mismatch.

And it is, it could be a very big problem with the designing. So, this curling, as well as spirality has to be minimized in a single jersey fabrics. These loops should remain stable, symmetric, so that the fabric appearance will be good. Because you can see here, the fabric looks tilted. So, it does not look good when the fabric loops are not stable. So, why this is happening? This is mostly prominent in spun yarn where in the spun yarn where you actually twist the yarn, either S-twist or Z-twist.

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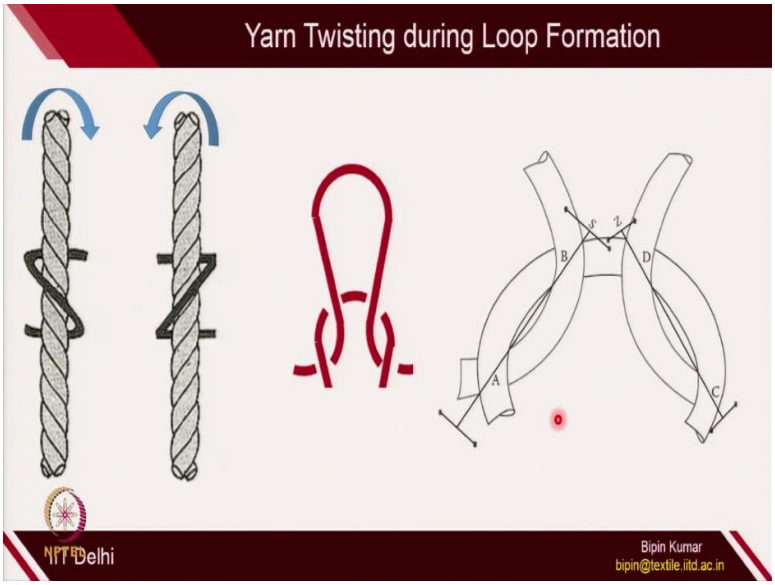

So, in a spun yarn, it which is made from a fibers; and the fibers are either S-twisted and Z-twisted. So, during the loop formation, what exactly happens is that, you can see the direction of twisting of S-twisted yarn. So, this is the direction of S-twist and this is the direction of Z-twist. So, during the loop formation, additional twist is imparted to yarn. So, for example, if you see the direction of this yarn in this loop.

So, this portion of yarn is matching with the direction of twist in s. So naturally, if you see this portion of the yarn, on the left side, the, this part of the loop is actually having additional S-twist, because you are bending the yarn in such a way. While if you see the right portion of the loop, it is actually bending in the form of z. So, this is, you can see, this is the z directions.

So, the same yarn, although we have already twisted, but during the loop formation, some part of the yarn is having increased S-twist; and some part of the yarn is having more Z-twist. So naturally, because of the twist variation in the loop, on the left side and right side, the loop cannot remain stable. So, this is what is happening here. On the left side, there is a additional S-twist.

And on right side of the loop, there is additional Z-twist. And because of that, the courses, not, does not looks perfectly horizontal. It will make certain angle, because all the loops in that course will bend.

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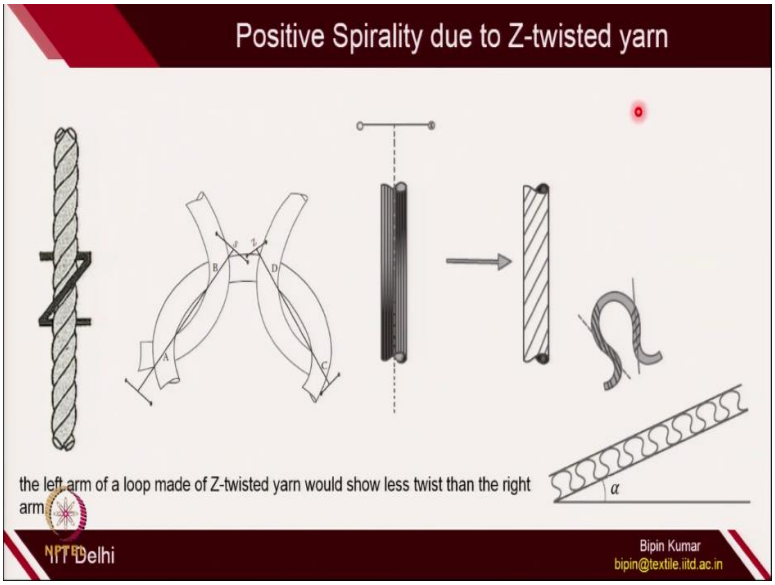

So, this is called a spirality. So, a spirality can happen in 2 ways. One is positive spirality. So, if you see, if you use Z-twisted yarn in the fabric. So, if you are making Z-twisted yarn on the fabrics; so, on the left side, because you are giving additional S-twist, so the twist of the left side of the loop will be less and twist of the right side of the loop will be more. Because, you are giving additional Z-twist; or here you are giving S-twist.

So, the same yarn, on one side will have less Z-twist and other side more Z-twist. So, because of that, the course will make certain angle with the horizontal which we have seen in the fabric photos also. So, when the, this course was supposed to remain in horizontal line, but it forms a spiral. Because, on the left portion of the loop, this is less twisted; and on the right portion which is high twisted.

So, the less twisted part actually bends very easily. And because of that, the whole courses looks and follow a different path. And this is happening because the left arm of the loop, made from S-twisted yarn; so less twist than the right arm. So, here the angle is positive. When you are using Z-twisted yarn in a fabric structure, the courses will be making positive angle.

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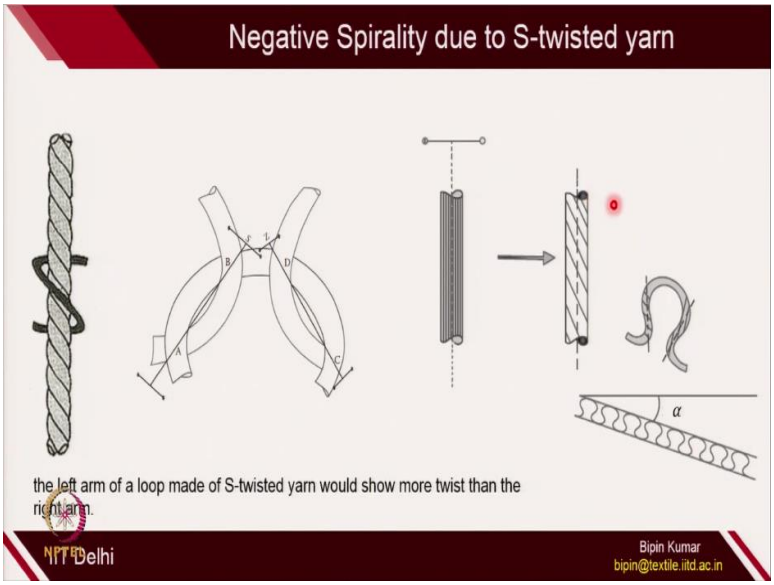

But when you are using S-twisted yarn; so, here it is a S-twisted yarn. So, on the left side, you are providing additional S-twist and on the right side, you are providing Z-twist. So, on the left yarn, you will be having more twist; and right side, you will be having less S-twist. So, because of that, the courses will bend in a opposite way. Because, the right side will become less twist, so it will bend more.

So, the all loop of that particular course actually follow the sequence of spirality. So, this is negative spirality. So, you have seen how the loop formation, not only disturb the straight segment of yarn, but also it disturbs its twist amount. So, once the twist is disturbed, the fabric does not remain stable. The, and the loops actually forms the spiral nature. So, this is very, very prominent, especially when we are using or making circular fabrics with spun yarn. There is a another big problem with single jersey fabric when it is being made on circular knitting machines.

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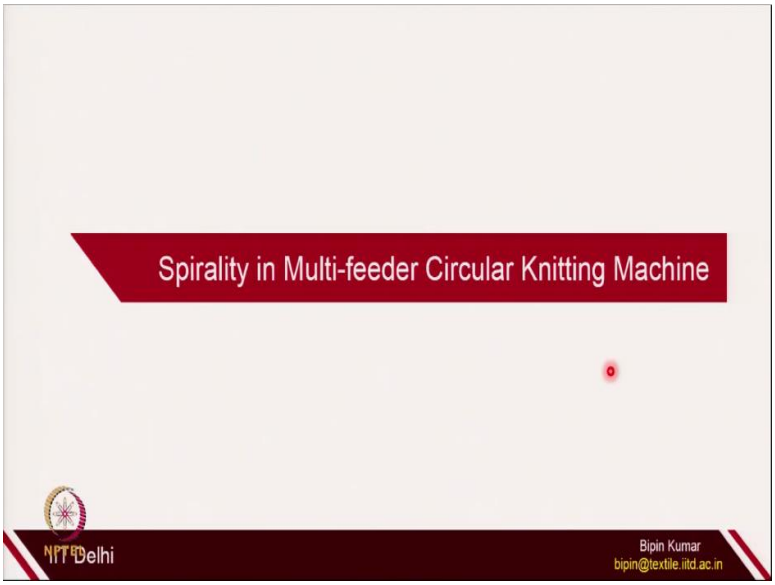

So, there also, another form of spirality can come. And the courses will not remain stable or horizontal. So, what do you mean by that?

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So, in multi-feeder single bed circular machines, where you have multiple number of feeders; here also, you can observe the same nature of spirality, even if you are using zero twisted yarn or filament yarn.

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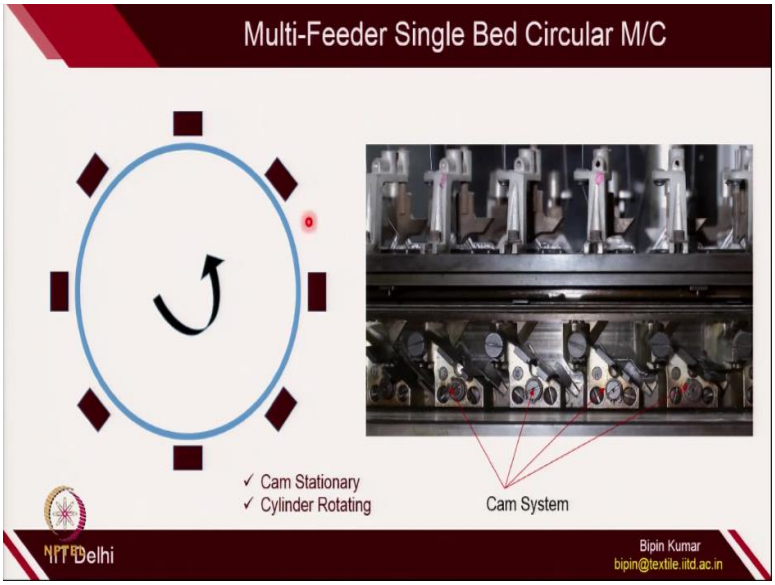

So, why is this spirality comes? Because, I have introduced you that, in a multi-feeder machines, each needle are making multiple loops in 1 rotation. So, you can see around the cylinder, there are multiple **(Video Starts: 09:00)** feeder points. And you can see this whole cylinder is rotating. **(Video Ends: 09:05)** And each of these are feeder points. So, right now, you can see at least 6 feeder points: 1, 2, 3, 4, 5, 6; and which is controlled by this cam jacket.

So, the needle is moving. So, I have shown you these videos in the previous lectures. You can follow it up. So, herein, because of the arrangement of multiple feeders on a circular machine, the course which is generated by each needle will take a spiral path. What do you mean by that?

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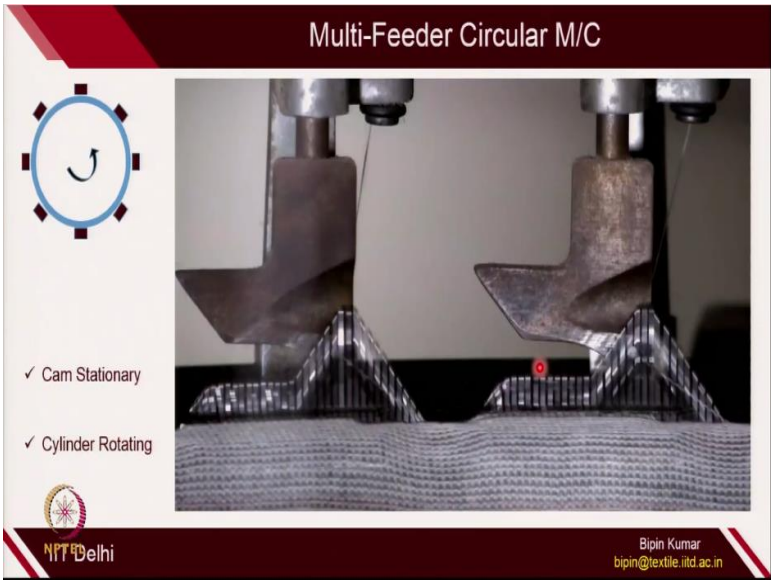

So, **(Video Starts: 09:47)** if you see, in a single bed machine, all needles are doing the function simultaneously and you are creating 1 course. So, in 1 course, **(Video Ends: 10:04)** actually, each needle is making only 1 loop. But, you can see here, since the cylinder is rotating, so the same needle in 1 rotation is making loop using this feeder also and with the next feeder.

So, depending on how many feeders it interacts, each needle is making those number of loops. So, in 1 rotations, you are not just only producing 1 course, you are making multiple courses. How is that possible?

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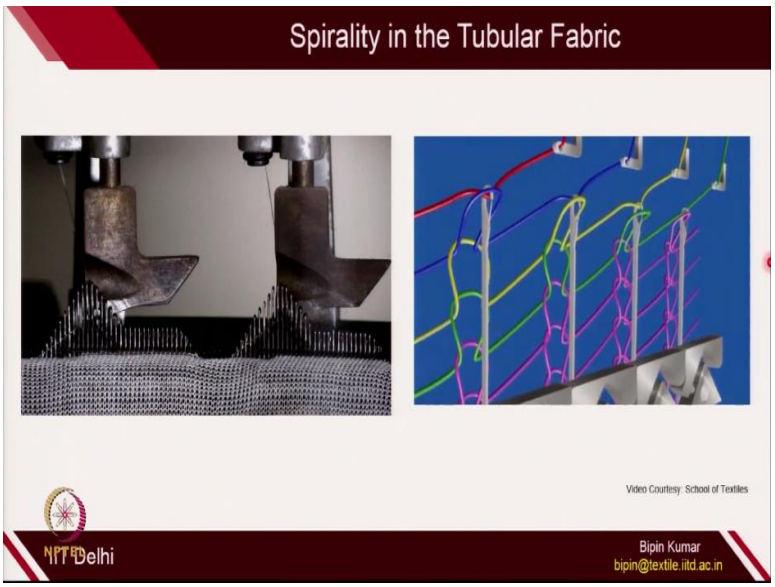

You can see here, the animations which will make you even more clear. **(Video Starts: 10:41)** So, you can see here. This is how the feeders are moving and the needles are making loop every time whenever it is passing the feeder. So, this can be generalized here also. So, you can see, the needles are moving and the feeder points are fixed. So, the needle first make the loop here. And then the, then this needle is making the loop here.

And you can see how the courses, how each courses is actually not making horizontal, it is making some spiral. It is making certain angle with the horizontal. Because, in 1 rotation you are creating **(Video Ends: 11:21)** multiple courses.

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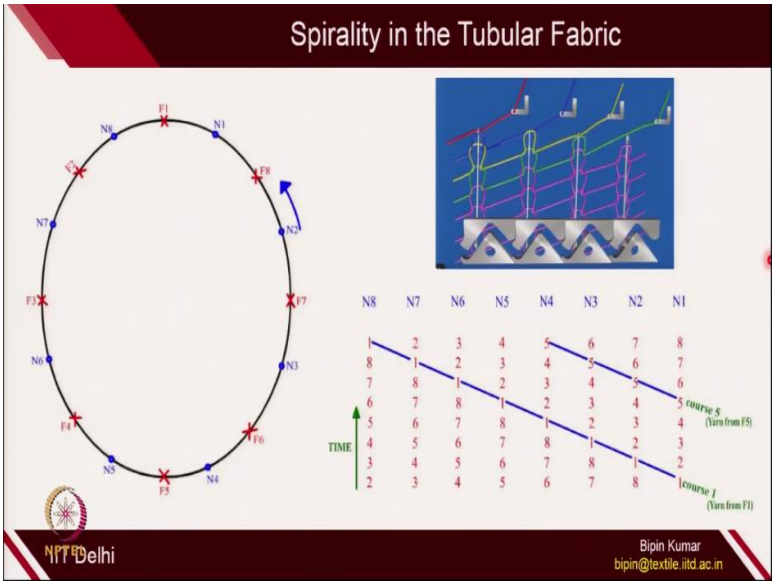

So, spirality is another big problem in tubular fabric, when it is created by multiple feeder points. So, here, let's suppose if you see this cylinder and there are N1 to N8 number of needles. So, there are 8 needles. And feeder number 1, 2. And there are 8 feeders. So, at a particular moment, if the cylinder is rotating anti-clockwise direction, so the N1 will first make loop with feeder number 1.

So, at this moment, you can see, the first needle is, the needle number 1 is making loop with the first feeder. Needle number 2 is now passing to feeder number 8. So, it will be making loop with feeder number 8. Then, needle number 3 will be making loop with feeder number 7 and likewise. So, at this moment, this is how the loops will be formed. After certain time, this N1 needle, this needle, will cross and pass through feeder number 1.

It will reach to feeder number 2. So, in the second time, the needle number 1 will be making loop from feeder number 2. But feeder number 1 will be providing the yarn to needle number 2. So, you can see how the loops in the course is not remaining horizontal, but actually it is forming the spiral. Because the timing of loop formation by the same yarn or same feeder is changed for each needle.

(Video Starts: 13:22) So, which is also visible here. So, for example, if you see, this needle is making with the green one. And while the other needle is taking the red yarn. Okay. So, because of that, because of the changing in the timing of feeder point, the courses will not remain **(Video Ends: 13:48)** horizontal.

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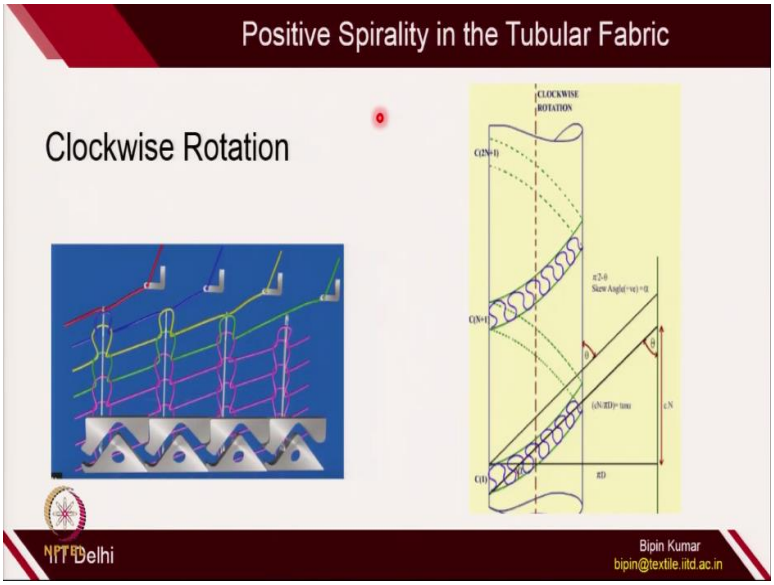

Again, because of this multi-feeder arrangement, the tubular fabric will have the spirality in the courses. So, once the machine is moving in clockwise rotations, **(Video Starts: 14:04)** you can see how this course will make the positive angle. Okay. So, this will make positive angle. Each course will make positive angle. So, this is clockwise rotation. **(Video Ends: 14:22)**

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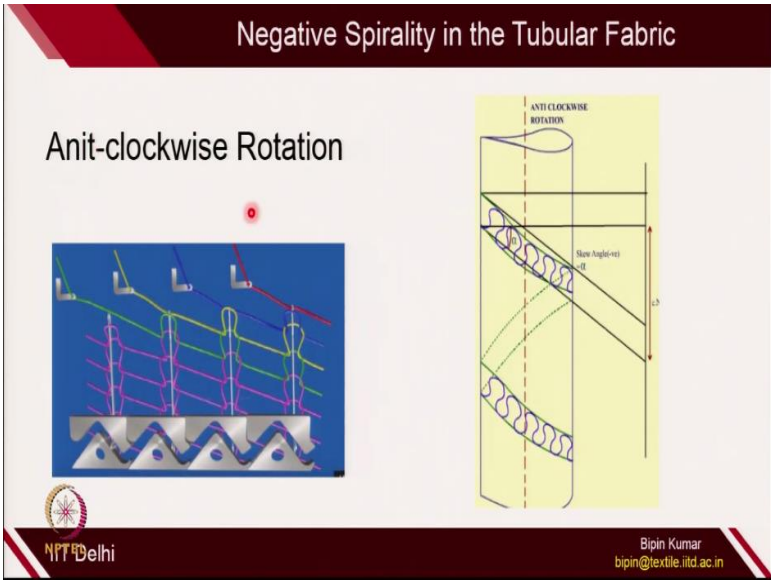

When the cylinder is moving in anti-clockwise rotation, the courses will make negative angle. So, this is the negative angle. So, anti-clockwise rotations will provide negative spirality and clockwise rotation will provide positive spirality. So, this is how the rotation of the cylinder is also very, very important and the number of feeder points. Now the question is, once the courses will look like this, the fabric appearance will not be good.

So, as a production manager, one has to make sure that the spirality in the fabric should be minimized. And all the courses in a particular point remain stable in the fabric. It should not follow a spiral path.

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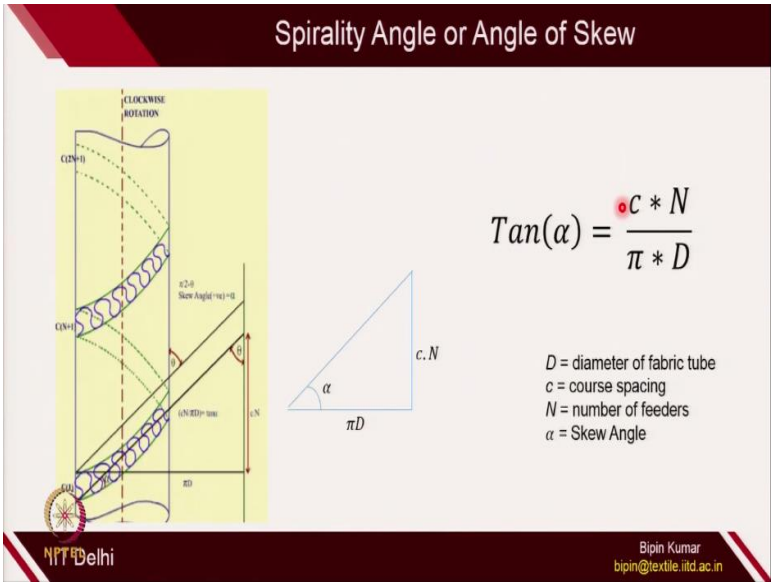

So, spirality angle, if you want, you can find out the spirality angle very easily, because it's simply a geometrical problem. So, this is the, you can find out the length of the 1 spiral. So, the loop is moving from here and it is finishing at this point. And again, the rotation will start. So, 1 feeder point, after moving to the other feeder point, the needle will start making the second spiral.

So, you can simply open up. So, this will be the hypotenuse length of the spiral. **c*N**, c is the courses spacing and N is the number of feeder points. So, a spiral will be repeating once the needle will cross all the feeder point in the circle. And once you open it, you know the diameter of the circular tube. So, once you open this cylinder, this distance will be **π *D**, which is shown here.

So, **π *D** is known. **c*N** is the course spacing and N is the number of feeders. So, this spiral length along the axis of tube will be known to you. With this, you can find out the spiral angle,**α**. So, **tan α= c*N/(π*D).** So, if you want to minimize the spiral angle, if you want to make **α** as a 0, you can keep either N very, very small or c very, very small. So, this is how you can minimize the angle of spirality angle. The other way to minimize the spirality is;

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Because you always want to make sure the fabric appearance remains stable. So, the other thing which you can do is;

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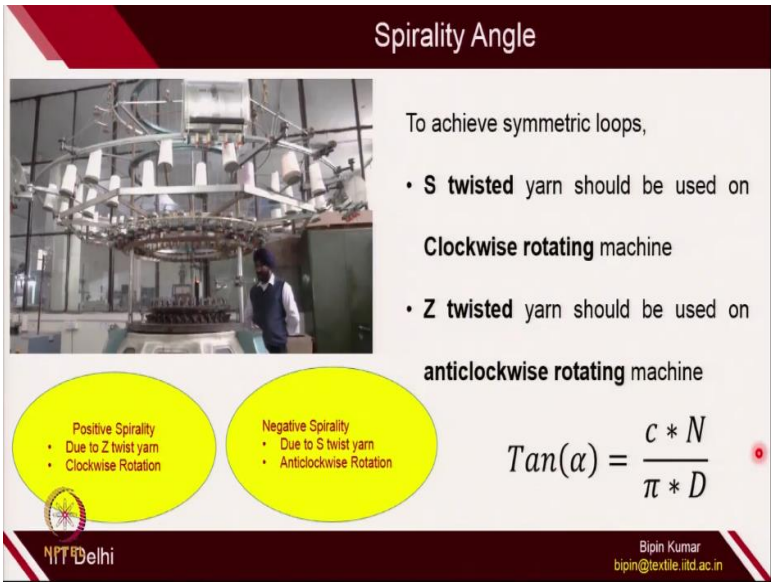

To achieve symmetric loops; if you want all the loops in a course remain is a perfectly same plane or same horizontal line, you can play with the nature of spirality due to spun yarn and nature of a spirality due to cylinder rotations. So, we have seen that the positive spirality is caused by the Z-twisted yarn as well as clockwise rotation of the cylinder. Negative spirality is happening due to S-twisted yarn and anti-clockwise rotation of the cylinder.

So, if I have to minimize the spirality angle or achieve a symmetric loop, some symmetric nature of the course, then, what we can do is like, we can take either Z-twisted yarn and anti-clockwise rotation of the machine, because they will cancel each other. So, S-twisted yarn

should be used on a clockwise rotating machines, because S-twisted yarn will give you negative spirality.

And clockwise rotations will give you positive spirality. So, these 2 will cancel each other. Or Z-twisted yarn should be used on anti-clockwise rotation machines. So, Z-twisted yarn will give you positive spirality and anti-clockwise rotations will give you negative spirality. So, these 2 will again cancel each other. So, not only technology is important, but for making good fabric you need to be very careful with the direction of rotation, as well as the nature of twist in the spun yarn. Now, let's do a very simple example. And then we finish this particular week. And we can see how we can minimize this spirality angle.

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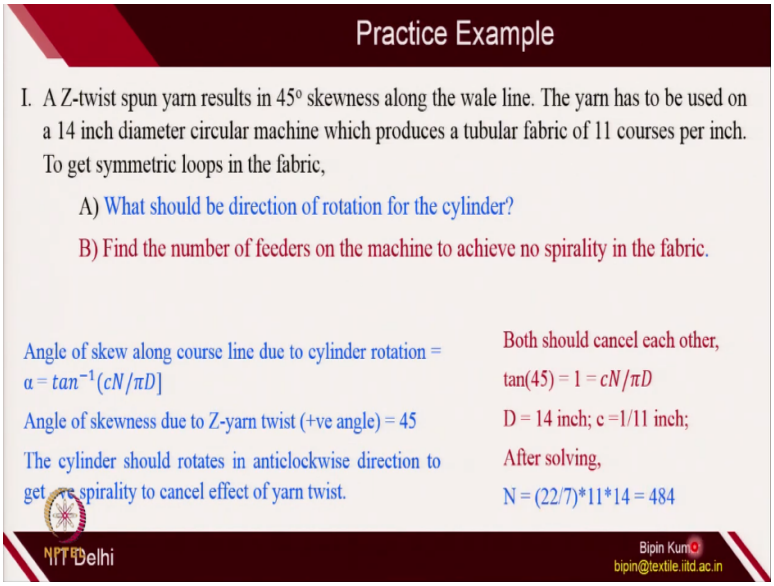

So, here is the example. A Z-twisted yarn results in 45° skewness along the wale line. The yarn has to be used on a 14 inch diameter circular machines which produces a tubular fabric of 11 courses per inch. So, to get symmetric loops in the fabric. The first question is, what should be the direction of rotation of cylinder. And the, find the number of feeders on the machine to achieve no spirality in the fabric.

So, you want the courses making zero angle with the horizontal. So, if you want to find out this, we can use those relationship. The first one, let's, what should be the direction rotation of the cylinder. So, here you are using Z-twisted yarn. And Z-twisted yarn, actually this is the relations we have already defined. So, Z-twisted yarn actually provides positive spirality. So, + 45° angles it will be making with the x axis.

And if you want to minimize the effect of spirality due to Z-twisted yarn. Naturally, this **α** should be negative, which is possible when the cylinder rotates is anti-clockwise directions. So, anti-clockwise directions will give you negative **α**. And obviously, positive angle and negative angle will cancel each other. And you can expect symmetric loops. Now, let's see the number of feeders on the machines to achieve no spirality in the fabric.

So, to achieve no spirality in the fabric, you know already how much spirality is coming because of Z-twisted yarn. So, which is tan45^{o}. So, both should be canceling each other. So, this 45 should be cancelled by this **α**. So, this should be equals, so **tan45=1= c*N/(π*D).** Course per spacing is known to you. So, D is 14 inch and course spacing in one is equals to 1 by 11, because 1 by capital C.

So**, C=11 courses/inch**. So, 1/11. You can put simply here c and D is known to you. You can find out the value of N. So, N is 484. So, if you want perfectly stable fabrics, you need to feed 84 feeders point on the machine. So, this is how spirality calculations is very, very useful in optimizing the fabric appearance. Although this is not relevant when you are using filament yarn, where there is a zero role of twist.

But whenever you are using spun yarn and when you are playing with multiple colors on the machines, then you need to be very careful with the spirality. So, with this, we are finishing this particular week. From next week, we will start with some other topics of the knitting. Thank you very much for the listening.