Science and Technology of Weft and Warp Knitting
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Module - 4
Lecture - 16
Single and Double Jersey Construction

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Welcome participants, in week number 4. Today we are going to see the topic related to single and double jersey construction. So, in last 2 weeks, in week number 2 and week number 3, we have seen a lot of technologies related to weft knitting machines. I have given you lot of demonstration related to single bed, double bed. Now, we are moving further, like how we can use these technologies to create different type of fabric construction.

Before we move further, let's have a quick recap of what technologies we have covered. Because, all these technologies has the potential to create different types of fabric construction. So, let's have a quick look on what are the technologies we covered so far.

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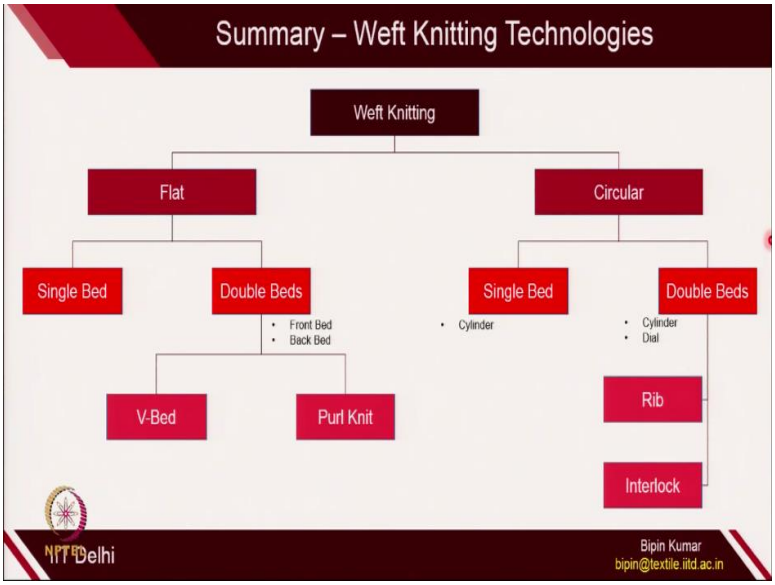

So, in weft knitting, we covered flat knitting technologies, where the needle bed is in the flat set. We also covered circular knitting technologies, where needle bed are in either in the cylinder and dial form. In flat bed, we can further categorize this technologies into 2 categories. Single bed, where you have just 1 needle bed. The other category is double beds, where you actually use 2 needle beds, front bed and back bed.

In double beds, we can further categorize V-bed and purl knitting machine. Similarly, in case of circular also, you have a single bed circular knitting machines, where you have just 1 cylinder on which needles are arranged. You have also second category in circular knitting is double beds, where you have cylinder and dial beds. In circular double beds, we further have seen technologies related to rib knitting machine and interlock knitting machines.

So, in totality, these are some of the common general technologies you can observe in weft knitting. Very recently, there are more than double beds are also found in flat category, especially 4 bed knitting, which is also called full garment knitting. This is, I am not covering this particular technologies at this moment. But, if you see, most of the knitting manufacturer, they either belong to flat and circular; either they do single bed knitting or double bed knitting.

Some recent developments are going on in developing 4 bed knittings for fully garments. I will cover that in subsequent weeks, but first, just have the brief understanding of these technologies.

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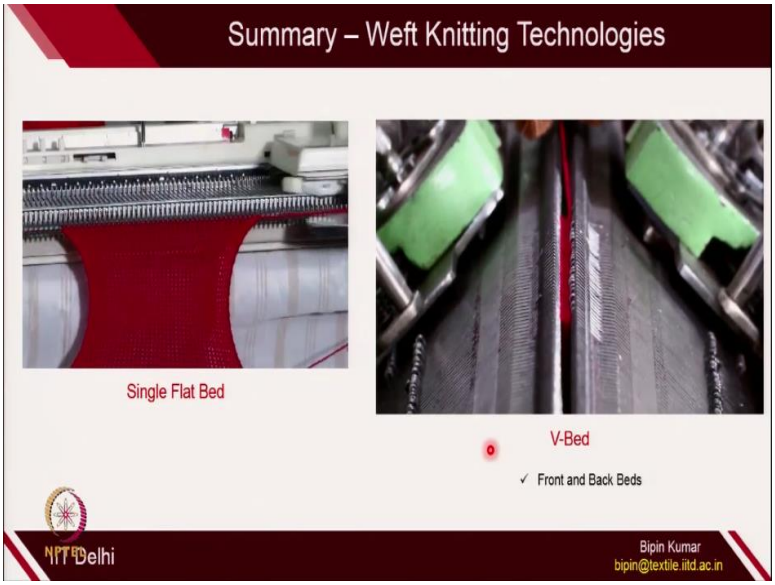

So, in flat category, I have given you demonstration on single flat bed; how you can arrange the needles on the bed tricks **(Video Starts: 03:01)** and you can run the cam jacket from left to right and right to left. In this way, you can generate fabric. So, this is single flat bed knitting. I have also demonstrated the V-bed knitting machine, where you have 2 beds. This is the front bed. The other one is the back bed.

You can also call it name differently depending on where you are standing. So, here also the same pattern of needle movements. Here only 2 needles are doing the reciprocative movements in opposite directions. Okay. So, I have given the demonstration in the lab also. I hope you would have understood how these **(Video Ends: 03:38)** technologies works. I have also given demonstration in circular knitting.

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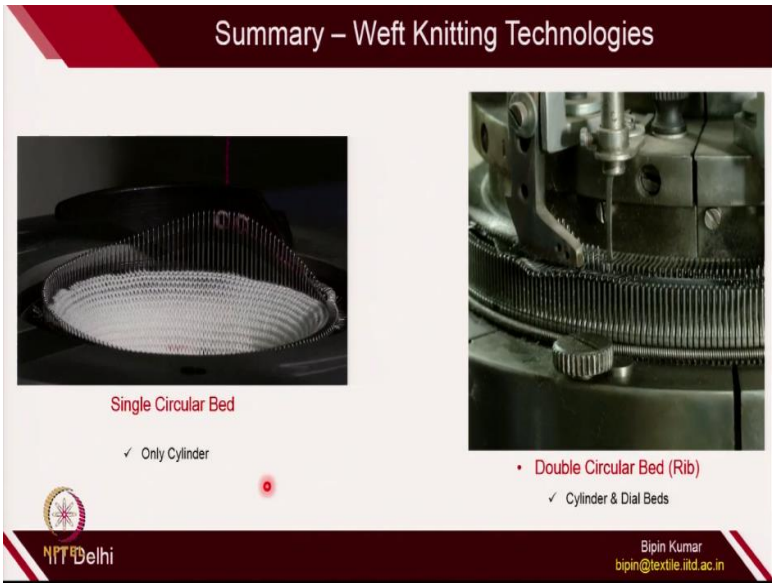

In circular knitting, you have single circular bed, **(Video Starts: 03:46)** where needles are arranged in 1 cylinder. They are doing reciprocation in the vertical direction. So, going up, catching the yarn and going down. In single circular bed, there is just 1 cylinder. You have also seen the additional element which is called sinker which plays a very important role, especially in single circular bed knitting; in fabric catching, holding, loop pulling.

(Video Ends: 04:11) So, sinker, apart from needle, sinker also have a crucial role to play in single circular bed. I have also given you demonstration in double circular bed, one of the machines is rib knitting machines where you can see **(Video Starts: 04:27)** cylinder and dial needles. They are placed on 2 different beds, one in cylinder beds and other is dial beds. Needles on the cylinder bed do the reciprocation in the vertical direction and needles on the dial bed do the reciprocation in radial direction.

So, in this way, they create double jersey fabric. **(Video Ends: 04:48)** The idea here is to differentiate 2 type of construction in knitting: one is single jersey fabrics and other is double jersey fabrics. And these names actually comes from the amount of bed which is being used for making these fabrics. So, in this week, particularly we are going to learn about fabric designing.

So, in designing, we first need to understand what are the available construction or the platform of weft knitting fabrics which is frequently used in the market. So, in this lecture, we are going to cover those aspects. Further in this week also, we are going to go further in the deep, how we can control the loop size or the loop architecture. So, this whole week is devoted in understanding the knitted construction in detail.

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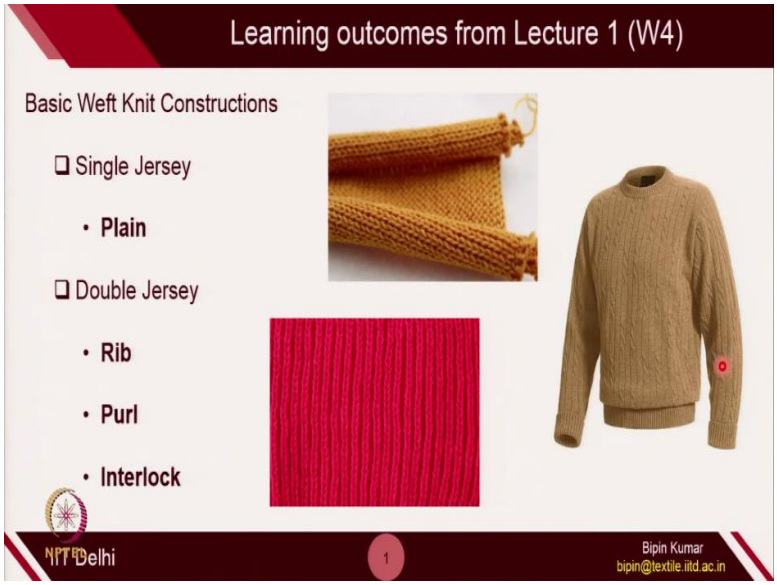

So, let's first start from the lecture 1, where I had divided this weft knitted construction into 4 categories. One is single jersey. In single jersey, you have just plain knitted construction. And in double jersey, you have 3 types of constructions which are quite popular in knitting world. So, these are 2 different fabrics which you can see, one is single jersey, one is double jersey.

Double jersey, further we have different categories of fabrics. And these fabric constructions has major role to play, because the nature of the fabric or the behavior of the fabric will change depending on what type of double jersey structure you are using. So, whenever you are making a full body garment or any garment related to knitting, you have to carefully choose these construction at different locations.

In this lecture, we first, we will understand what is the role of these constructions, what is their properties, how they behave and where they are used. Let's start with the first one. Although you have seen the single jersey's construction a lot, in last 2, 3 weeks; but now, I am going to summarize what is the basic characteristic of these type of fabrics.

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The single jersey fabrics usually, one of the construction which is very popular is the simple plain fabric. So, in simple plain fabric, you create this on the single bed machine;

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(Video Starts: 07:03) Thats why it is single jersey fabrics. And we call this as a plain, because you have either technical front or technical back loops on the surface. So, this is the actual photos of the fabric. So, if you see, one side, you will either observe technical back side of the loop, which is denoted by here. So, the fabric can be represented by either circle in the box or cross in the box, depending on which side you are looking at.

So, on the back side, here the head and sinker part is visible. And this is the fabric notation. If you flip that fabric, you will observe the leg part. You can see here, this is the leg part which is bend. This part of the fabric is the back part. So, on front side, the nature of loop is

represented by technical front and we denote this type of loops by cross. So, the fabric remains same, only the way you are looking at this **(Video Ends: 08:03)** fabrics, we have to give different representation. If you see the basic characteristics of these fabrics;

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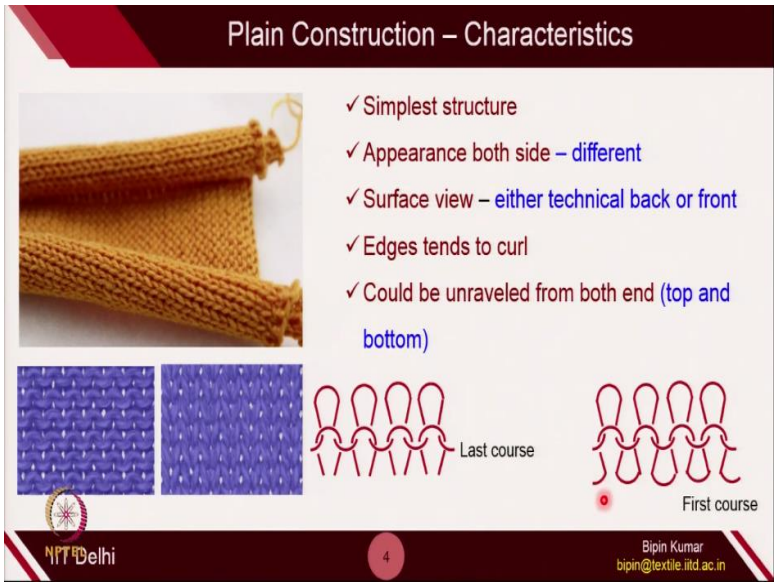

Is the most simplest one, because you are either making technical front or back loops depending on what machine you are using. The appearance is different on both the sides. So, on one side you can see here, if you flip that, the side will look different. On technical back and front side; on technical back side, you can see the head and sinker loops; and on technical front side, you can observe the leg part.

So, this is how the appearance of the fabric will be different. So, if you are making the t-shirt, the nature or the aesthetics of the t-shirts can change, how you have connected those fabrics. So, whether you are cutting the fabric and using the technical front side, then it will look like a vertical V, the legs. And if you are using the back side, you will observe the curve part of the yarn which is the head and the sinker part.

The other characteristics of these single jersey fabric is, it curls from the edges, which we have already covered in week number 3. So, fabric curling is one of the basic problem of single jersey fabrics. Thats why we go for double jersey structure. So, the curling nature, you can see, it curls either from the course direction or wales direction depending on where you are folding the fabric.

So, the other basic characteristics which I have also shown in the demo number 1, in week number 1, it can be unravelled from both ends. So, if you make the fabric and if you catch the yarn from the top part and the bottom part and if you try to pull the yarn, you will realize all the loops will unravel. And the fabric will be completely disappear and you will get the entire yarn.

So, for example, in the last course, which you will weave on the machine, the loops will be like this. So, the moment you start pulling the loop from one side, from this side, you can see there is no holding for the head. So, all head will just come out from the bottom loops. So, all these loops will just come out and you will get a straight segment of the yarn. So, last end of the course, the last course which you knit on the machine will be unravelled very easily by pulling the yarn.

I have showed this in demo number 1. So, if you go back and you can see how you can do the unravelling from the top side, top side means the last course which you knit on the machine. Also, if you see the first course, first course, although it looks like the head is locked by the top loops, but the sinker loops are free. So, the moment if you pull from any one of ends, you can see these sinker loops will come out.

And if sinker loops will come out, these, none the loops will remain stable, it will come as a straight yarn segments. So, from the first course or the bottom most course on the machine, you can also unravel by pulling the yarn. So, this is the basic nature of this fabrics, that it can be not only unravelled from both ends. So, that's why, you need to fix the ends, whenever you are using it on a fabric.

Otherwise, if any ends are free, you can see how it can unravel. And the second thing, it curls from the edges. So, it is very difficult in sewing and providing stability to the fabric plane. So, this is the reason why this fabrics are not so much popular especially in the edges, because it can create lot of problem in garmenting. In plain constructions, we have also given more emphasis on the loop projection. So, if you see the nature of loop;

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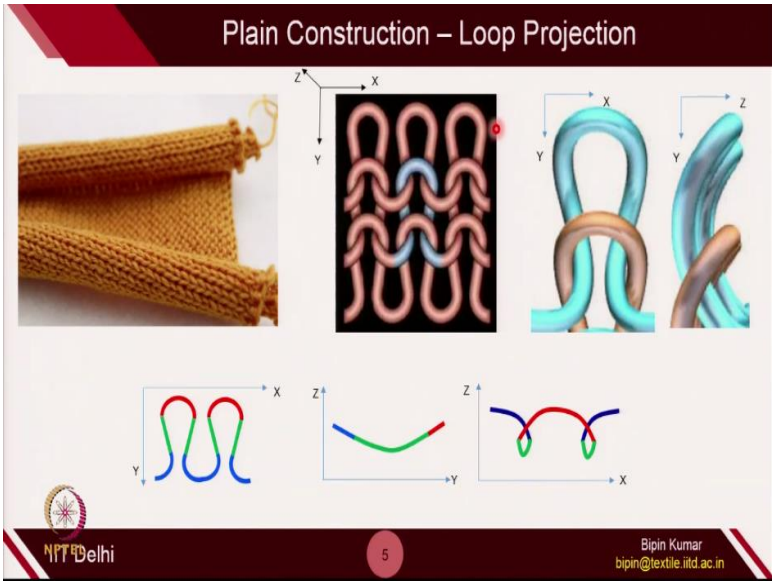

The yarn are actually bent, not only in x-y plane, but also in other planes like z-x plane and z-y plane. So, in x-y plane you can see, it is bend in a loop form. But in z-y plane also, you can see the nature of loop is actually in the bent form. And this is why the yarn will try to go back to its original straight configuration and it will try to bend. And this is the reason why the curling was happening.

So, we have seen the projection of these type of loops. So, in x-y plane, it will look like a perfect loops. In z-y plane, if you see the z-y plane, you can see, each loops look like a arc. Okay. So, this is the arc. So, the leg part is going down and coming up. And this red part is the head part of the loop and blue part is the sinker part of the loops. Apart from that, if you take the projection of loop in z-x plane, it will look like this.

The projection is very complicated, but it will give you the understanding of the mechanics about the fabric, how the fabric will try to curl. So, this is very, very important. So, because, if you see the nature of this bending, if you see the nature from here, this loops will try to rotate in anti-clockwise direction. If you try to see, it will try to rotate in anti-clockwise direction. Because it is locked here, so it will try to rotate in anti-clockwise direction.

It means, the z will decrease. So, if you see the plane of the fabric, the top loops it is actually going, want to go behind this plane. It means, it is trying to go towards the front side of the fabric. So, this is why, along the course, this fabric try to curl from the back side to the front side. And if you see a wale direction, the nature is opposite. It will try to come from the front side to the back side.

You can see here also. From the front side, the curling is towards the back side. So, this is how the nature of projection decides the mechanics of the fabric. So, this is very, very important. If you understand this, this will be very useful in structural engineering about knitted structure, which is often ignored in many research articles.

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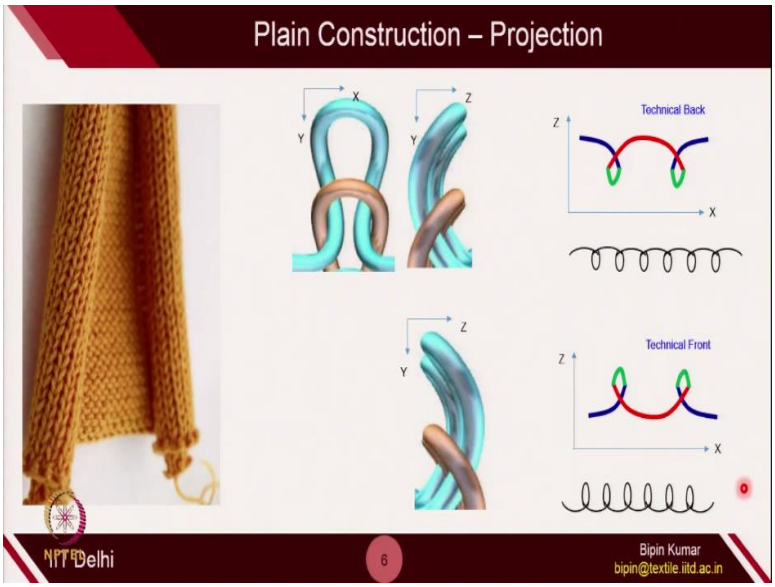

Again, let's see this construction part. So, in y-z plane, the yarn is bent like this. In z-x plane the nature of the loop projection is like this. So, this is basically the technical back sides, because you are watching the fabric from the right side. You are watching towards this direction. So, technical back side, all the top loops will look like this. But if you flip the fabric, if you flip and watch from this side, the nature of projection will be just reversed.

It, just like the mirror image about horizontal axis, so the nature of loops will be like this. So, this is the technical front side projection of the loop. So, depending on how you are standing in front of the fabric, the projection will also change. And in technical back side, it is like this; technical front side, it is like this. So, this is all loops projection along the course.

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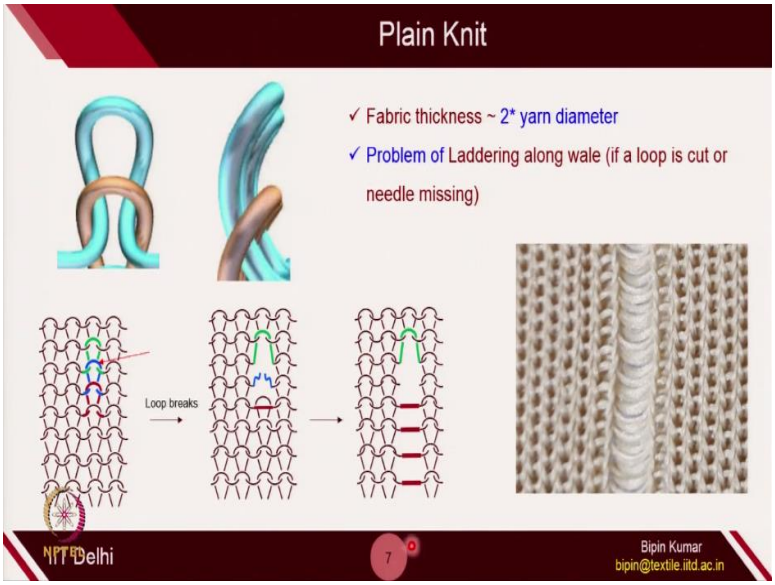

If you see carefully this fabric and if you want to find out the thickness of the fabric, naturally, you can see, the minimum thickness the fabric can observe is; because the head is above the leg part, so, minimum 2 times the yarn diameter which is being used in the fabric. That will be the minimum thickness of the fabric. Naturally, this thickness can be more, which will depend on how much it has bent.

But, the minimum thickness which you can observe in any knitted construction is 2 times the yarn diameter. And you can see it here. So, if you measure it at any point, the whole head, the yarn diameter is consumed. And above the head, again the leg part is also have additional yarn diameter. So, 2 times yarn diameter is the minimum thickness you can observe on a plain knit fabrics.

And naturally, this thickness will be more which will depend on how much curvature of the yarn is there inside the fabric structure. The other problem with plain knit construction is the laddering; laddering about a wale direction. So, I have given you a hint in lecture number 3, in week 1, where you have seen like, if any of the loop is break, then the entire column will just fade.

This is how, because if any of the loop will break, then it will not support that column in the bottom. So, because of that, the all the sinker part will try to become straight. You can see here, all the sinker part is becoming straight of the adjacent columns. And this is how you can observe a kind of laddering behavior. So, it is just like a ladder. You are rising above in the vertical direction.

So, this is the actual nature of laddering you can observe. So, just one loop break; and the moment you stretch the fabric, you will observe most of the yarn will become straight in that particular column, because there is no loops which is holding the bottom loops. So, all the bottom loops will not be supporting the next bottom loops. And because of that, the laddering will be observed. Now, let's move to the next category of construction which belongs to double jersey fabrics.

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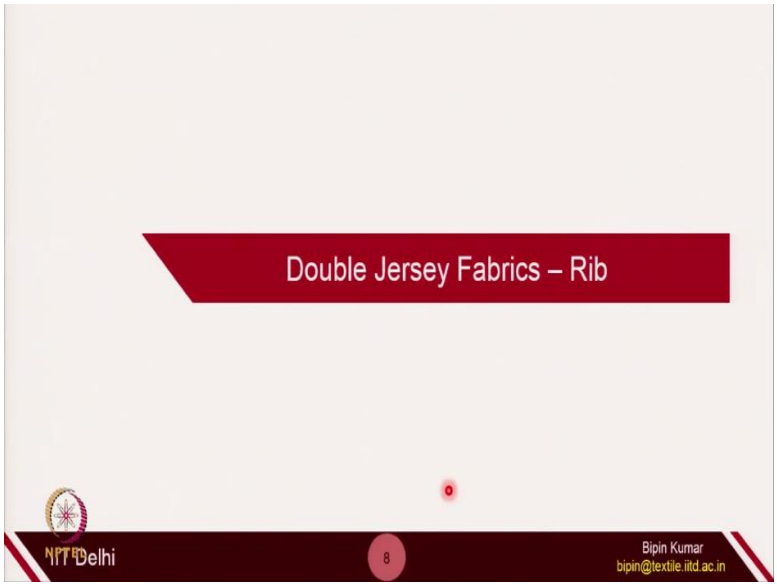

So, in double jersey fabrics, the first **(Video Starts: 17:45)** constructions which is the most popular one is the rib construction. So, although you have seen the word rib which is used in knitting technologies to define a machine especially rib circular knit machine, where there was a cylinder and dial. And rib was defined, how the needles gating was done for that particular machine. **(Video Ends: 18:06)**

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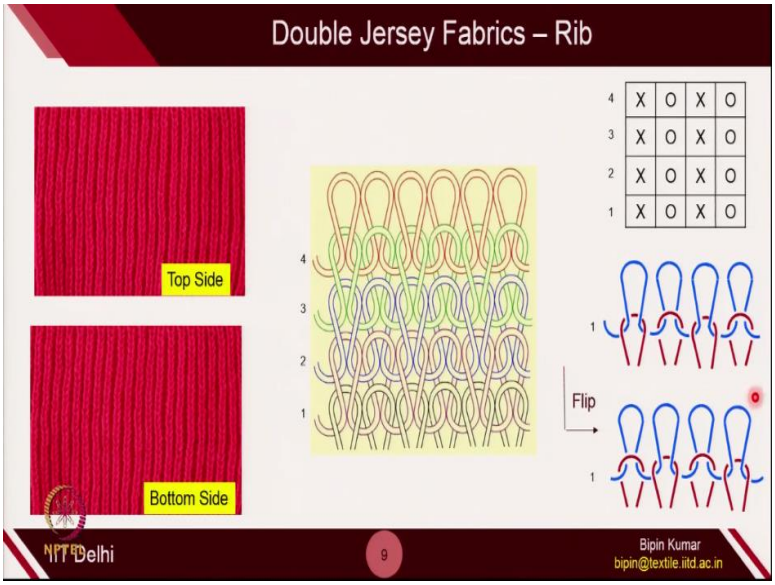

In double jersey fabrics, rib is the first one where you will observe technical front and back loops on the same side of the fabrics. So, you carefully see the loop behavior. This is the first course. If you carefully see the entire course and from left to right, the first loop is going technical front, the second one is going technical back; then front, technical back. So, alternatively, along a course, you are getting technical front, back, front, back.

Similarly, other courses are also repeating the same nature. So, here you can also observe. This one is technical front, because loops is coming on the front side. In the second column, the loop is going on the back side. So, this is alternating columns or wales are either technical front or back. So, this is how rib construction is different from a single jersey constructions. Because, in single jersey constructions, either it was all 0, which is technical back; or, it was either all cross, which is technical front.

So, if you flip this fabric, if you flip this particular 4 loops or if you flip this fabric, the nature will remain same and this technical front will become technical back. And the next loop will become technical front. So naturally, whatever is looking technical front on one side, it will look technical back on the other side or on the opposite side. So, if you flip this, the all the loops which is there on the first column, which was technical front, it will look like technical back.

And the next column which was looking technical back, it will be looking technical front. It is just the way you were looking at; from one side or the opposite sides. So, if you see the surface, again, the nature of the surface will not change. Because, if it is looking on the one

side, one technical front, one technical back, on the opposite side also, it will look exactly the same. So, the rib fabric will look same from either side.

So, in one of the demonstrations, in last week, demo number 5, where I was analyzing the double jersey rib construction, you might have observed this. That the fabric was looking same on the top side as well as bottom side. And the nature is because of this. So, both side it looks same. Because, after flipping, the all technical front loops will become technical back, and all technical back loops will become technical front.

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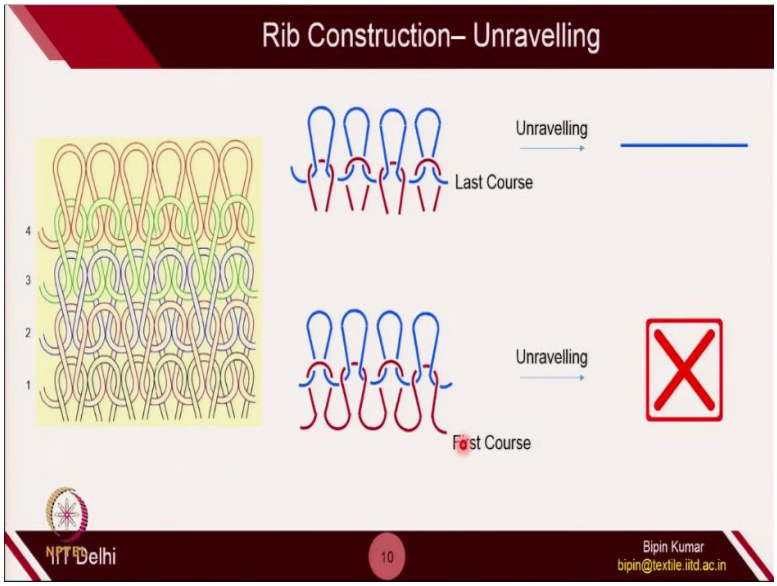

Now, let's see rib construction, can we unravel the yarn from the ends. So, you have seen in single jersey plain construction, if you are pulling the yarn from the last course or the first course, you were able to take out the yarn from the fabric. So, the fabric can collapse from either side, from the top side or the bottom side. But if you see, the rib construction, the last course which you make on the machine, if you try to pull the yarn, naturally, the head is not supported.

So, from this column, this head will come out if you pull from the right side, this head will come out. Then again, this column, the loop is again not hold by the above loops because it is the last course. So again, this will also come out. The third column, this will also come out from the front side. And the last column, this will also come out from the back side. So, if you pull the yarn from one of the end, the entire course will just unravel.

So, this I have also demonstrated in a demo number 5, you go and see the video, how I was unravelling the yarn from the last course. But if you see the nature of unravelling at the bottom most course, bottom most course means, in the first course which you create in the fabric. So, the first course, if you try to pull it, although head is locked, so head cannot come out. But this sinker part, if you are pulling from this end, this sinker part will try to come.

But if you carefully see this sinker part, the yarn is first coming from the back side and then going towards front and then again going back. So, if you see, this, actually this sinker part is locked with the sinker of top loops. So, this sinker part is basically locked with the sinker of top loops. So, this is why, when you are pulling this yarn, this loops are not able to unravel. So, rib construction, you can do the unravelling either by only one side which is the top side.

Top side means, the last course which you make on the machine. But the first course which you make on the machine in rib construction, it will not come out easily. And this is why, in most of the t-shirts, the edges are made from the rib constructions or double jersey constructions, because you cannot unravel, especially the rib category. So, unravelling, if you unravel the last course, it will just come out.

If you try to unravel the first course, the bottom most course of the fabric, it will not come out. So, unravelling nature is, of a rib construction is entirely different from a single jersey construction.

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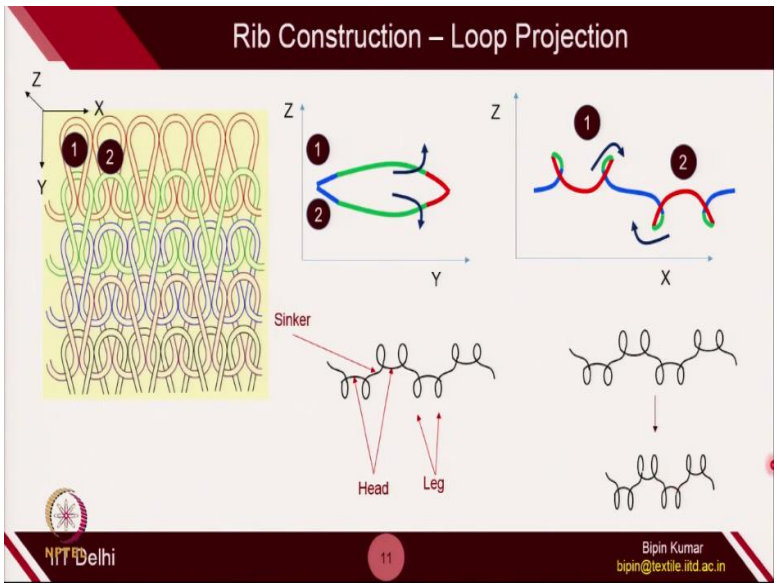

Now, let's see the loop projection. You have seen single jersey was curling. In one of the classes, I have given you some hint, why this rib construction was not able to bend, because of the counter effect of the adjacent loops. So, if you see any course, let's suppose if you see this course, this is technical front and the projection in z-y plane will be like this. If you see the second loop, which is going on the back side, naturally, the projection will be different.

So, the nature of curling will be different for adjacent loops. And this is why they will be countering each other. And the nature of the course is like, every adjacent loops are different. This is why the net curling nature will cancel out. So, this is why the rib construction was not able to bend either directions. If you see the z-x projection in this plane, if you see the projection, the technical front will look like this.

When you take the projection of back, it will look like this. And technical front and technical back is connected by this blue part which is nothing but the sinker. So, this sinker part, if you see this sinker part between 1 and 2 loops, it is denoted by this blue segments. So, if you see the z-x plane projection, which is the most important, you need to really understand this very well.

If you take the projection of all the loops here, the projection will look like this. So, this is technical front side, this is technical back side, this is technical front, then back. This is how it will go. In these projection, if you try to see which one is the head, leg and sinker part. So, this part, the red one is nothing but the head part. And if you see the lobbed one, this small circle if you see, it looks like elliptical; this is nothing but the leg part.

And this 2 adjacent leg part is connected by this curved section, this one, the blue one is nothing but the sinker part. So, if you see the projection of z-x plane, you can easily observe that only the leg part is on the surface. But the head part and the sinker part is behind, the z coordinate is actually in between the leg coordinates. So, this is why the head and the sinker part was actually hidden inside the fabric.

And only the leg part was visible from the both the sides. So, this is the reason why the fabric was looking similar from the both the sides. Because the head and the sinker was hidden between the legs. Okay. Because this legs are on the top and also at the bottom most position.

Now, if you see the curling nature of 2 adjacent loops, you will observe a very strange behavior. If you see the first loop, it will try to curl like this.

And if you see the second loop which is technical back, it will curl like this. So, what naturally will happen? Because this is supporting each other, so this loops is trying to rotate in clockwise direction and the other loop is trying to, also rotating clockwise direction. So, this is why these 2 loops will support each other and these 2 loops will try to become close with each other. So, if you relax this fabric, after relaxation, you will observe the entire fabric width will shrink.

So, on the machine, let's suppose, if you are making 1 meter of the fabric, but once you take out the fabric from the machine, if you put it on a table; after relaxation, you will observe hardly 60 centimeter will be. So, more than 30 to 40% of the fabric will shrink. And the shrinking nature is coming because of the rotation nature of this fabric. So, especially the sinker part and the head part will try to collapse.

And now you can see here, the head and sinker is not visible. Only the leg part is visible from upper side as well as from the bottom side also. And if you see 2 leg part, you can see the sinker and heads. So, if you extend the fabric, you would be able to observe the sinker and head part. But in relaxed condition, this sinker and head part is not visible, because the fabric has shrink. And because of that shrinkage, the head and the sinker get collapse.

And it is in between the fabric layers. This is how the loop projection in rib construction is so useful in understanding the fabric mechanics. Now, let's see the basic characteristics of rib.

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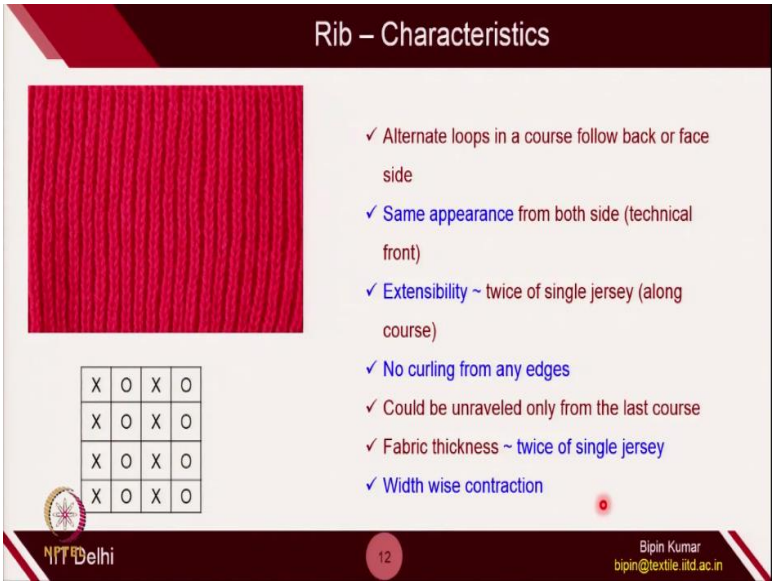

So, in rib, you can observe alternate loops in a course, following back and front side. So, either technical front and back, front and back, along the course. You will observe the same appearance from the both side. Just now I mentioned from the previous slide, how the head and the sinker was hidden because of the shrinking nature of the fabric. So, on both the sides, you will see the same.

And also, if you carefully see this fabric, it has the rib, a vertical line breaking this fabric can be easily visible. So, a rib type appearance is visible. This rib appearance between 2 column is nothing, is actually showing the head and the sinker part. So, if you stretch this fabric, between any 2 columns of loop, this line will extend and which will let you know the head and the sinker part.

This is the basic nature of the rib construction, which is completely different from the plain construction. If you see the extensibility. Extensibility is very huge, especially in course direction. The reason being, the previous slide also I have shown you how this sinker was collapsed and the fabric was shrink. So, the fabric is actually shrink too much. So, if you try to extend along the course direction, all that sinker part and the head part will open up and the fabric will have maximum extensibility.

So, you can extend the fabric very easily in course direction, because of the nature of this loops. No curling from the edges. Because all the bending behavior was counter by adjacent technical back and front loop natures. Also, I have shown you how you can do the

unravelling only from the last course. So, this is the difference between single jersey and double jersey; why double jersey are used in the edges.

Because, the first edge you will create, the first course in the edge which you will create while making garment will not unravel. Only the last course is going to unravel. So, all the edges are perfectly stable in the fabric. The fabric thickness, if you see, because of the nature of the loop all technical front loops will come on the front side. It will actually become projected from the plane.

And because the sinker part was bending, because of this, between 2 technical front loops, the opposite bed loops is actually projected towards the back side. Because of that, you will observe the thickness of the fabric is too much compared to single jersey. In single jersey, I have given you the hint that the minimum thickness is 2 times the diameter. But in case of rib construction, you can get the fabric thickness around 4 times the diameter of yarn.

Width wise contraction: So, the rib has one of the demerit that, the moment you make the fabric on the machine, you put it on a table to relax, you will observe lot of contraction or shrinkage in width direction, which I already mentioned this. So, these are the overall basic characteristics of rib construction. In rib, there are a lot of varieties are also possible. Like, you can generate 1 cross 1 rib.

You have technical front and back adjacent alternatively. In case of 2 cross 2 rib; so, you had 2 technical front, then 2 technical back, then 2 technical front, then 2 technical back, along the course. So, this is how 1 cross 1, 2 cross 2, 3, cross 3, 4 cross 4. Depending on how many needles you want to participate on either of the beds, you can design different rib constructions. And each of these rib constructions will have different nature.

So, in one of the lecture, I will show you all these fabric samples, how they behave, what are the nature, how they are different, so that you will be able to understand the mechanics part of the fabric. Now, let’s go to the third category of double jersey fabric which is called as purl.

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So, purl also, usually, there was a machine in double jersey flat bed knitting, I introduced you. So, the purl comes from that machine name itself. So, the purl fabric, the nature of the loops are **(Video Starts: 33:54)** like this.

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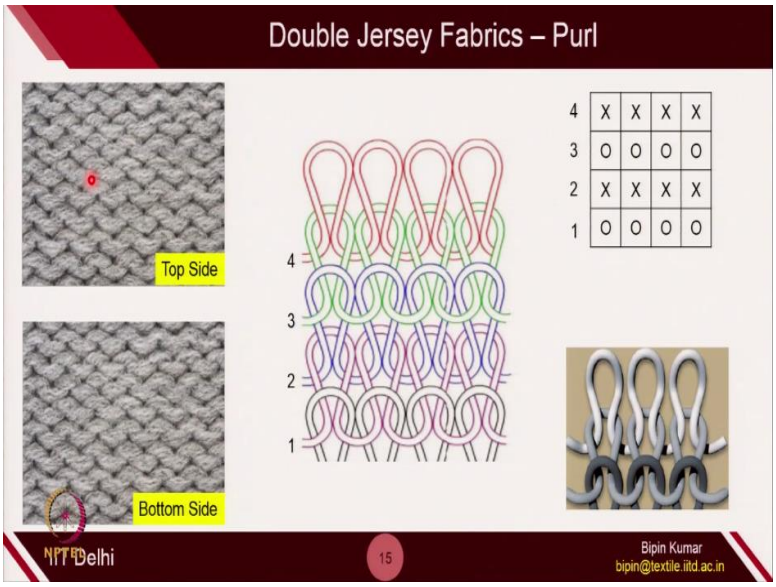

It is different from rib constructions. But in purl, you have the entire course of loop is either technical front or back. And these nature of courses are alternatingly changing with either technical front or back. For example, here if you see the first course, the red one, it is going technical back side. So, this is technical back loops. If you see the front loops, these are all coming on the front side. So, it is shown in cross.

Then the green one is going back side, the red one is going on the front side. So, this is how; so, you can see here, all the, these grey loops are going back side, all white loops are coming

front side. So, the entire course has similar nature, but alternating course has different nature. This is how purl is different from a rib construction. In rib, alternating loops in the same course have different nature.

But herein, the course has same nature, but alternating course has different nature. So, if you reverse this fabric, again **(Video Ends: 35:04)** all 0 will become cross and all cross loops will look like 0. So, technical front loops will look like technical back and technical back loops will look like technical front. The nature of the surface will remain same on both the sides. But the key issue here is, if you see the purl, only the curved part of yarn is visible.

It means, only the head and the sinker part is visible, not the leg part. And if you see the rib construction, only the leg part was visible. So, only v was visible on both the sides. But in purl, you can see here, only the sinker and head part was visible. This is how they are different.

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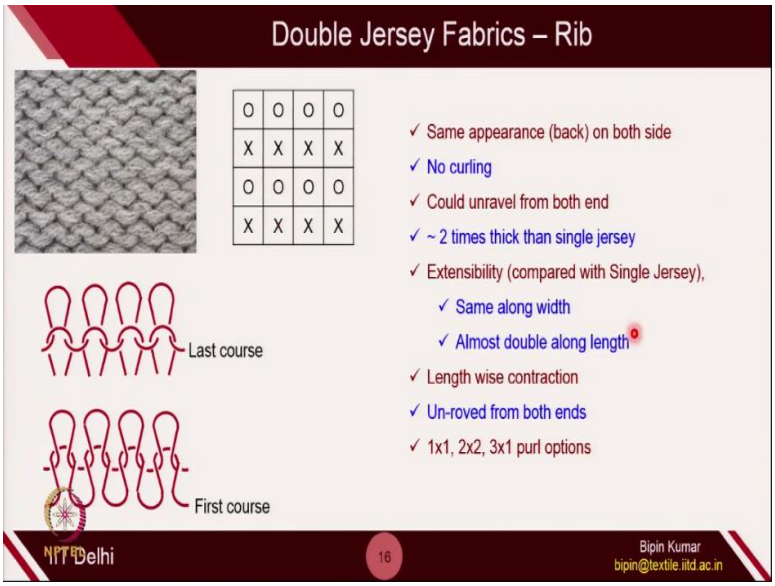

Again, if you try to see the characteristics. It has some basic characters, like it has same appearance on both the side. And on both side, only the technical back side of the loops is visible. It means, only head and the sinker part is visible. Again, because you have technical back and front loops; so, if you see the projection, the nature of curling will be counter by other loops.

So, overall curling nature will be 0. So, there will be no curling from the edges. If you see the unravelling; so, if you pull the last course, the nature of all the loops are same. So, it will

come out. There is, the head will come out if you pull the last course. If you pull the first course, whether it is technical front or back, the nature of loops are same, because they are made on the same side.

So, if you pull the yarn, all sinker loops will come out and you can unravel the fabric from both the sides. This is how the purl construction is different from rib construction. 2 times thicker than the single jersey, because it shrinks along vertical directions and legs are actually hidden inside the fabric. Only the head and the sinker part is projected from both the sides. So, that's why, it has 2 times thicker than the single jersey.

Extensibility: If you compare extensibility with single jersey, it has same extensibility along width, but has double extensibility along length direction. Length wise contraction: Because the leg part is actually hidden between the loops; so, the fabric actually shrink along the length direction. You can do the unravelling from both the sides. In purls also, there are lot of possibilities: 1 cross 1, 2 cross 2, 3 cross 1. That is possible.

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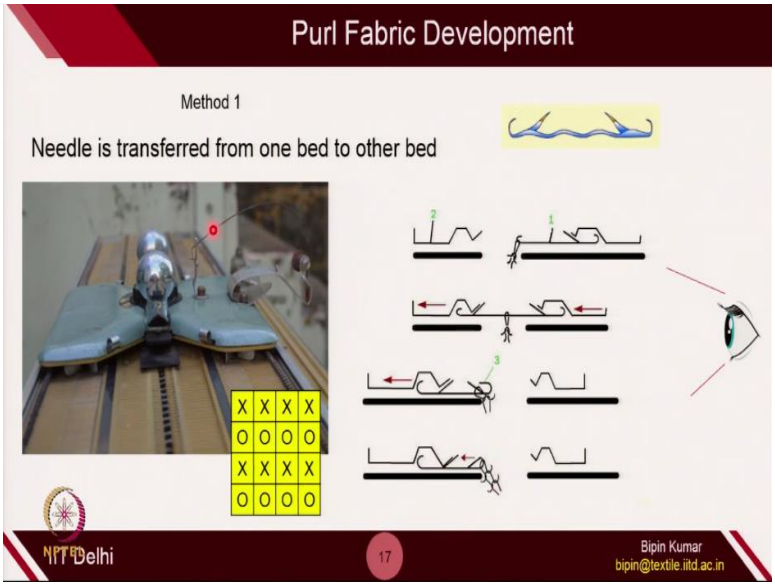

Purl fabric development: I have also shown you how you can develop the fabric on purl knitting machines. For developing purl fabric, you have to transfer the entire needles from one bed to another bed. For example, if you are watching the needle movement from one side, this bed is pulling all the loops towards your eye. So, thats why, this is making technical front side. So, all the loops which is being formed on this bed is technical front.

So, you can see here, all technical front loops are being formed. After that, this double hatch needles is transferred to the other bed. And here, you are making the entire course of technical back loops. So, this is how you make the purl fabric on purl knitting machine.

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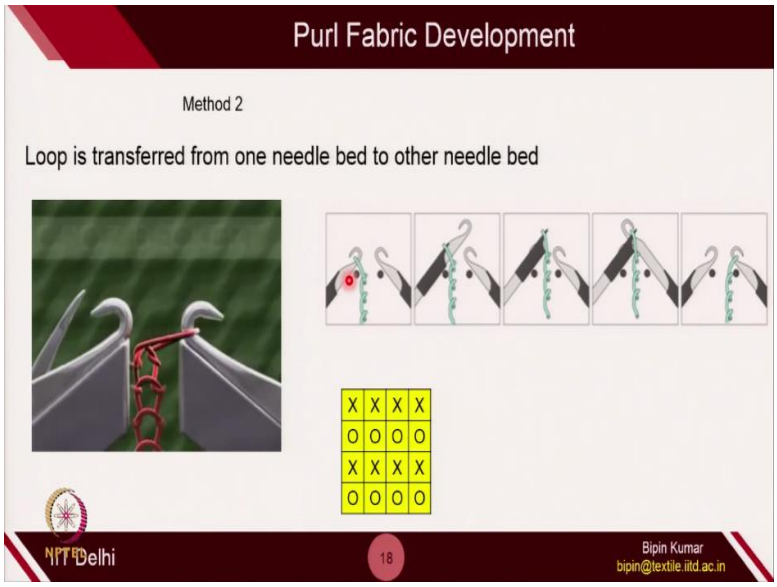

In some of the V-bed machines, there is also mechanism to transfer the loop from one bed to another bed. In one of the advanced machines, you will realize the needles has some extra slot through which it can actually transfer the loop from its own body to other needles. You can see the animations, **(Video Starts: 39:05)** how you can this transfer take place. So, here it first make the loops, then it rise certain, at certain height.

Then you have the jack part through which the head goes and this is how you can basically transfer the loops. So, this is how you basically transfer the loops. So, once the bed could able to transfer the loop from one bed to another bed, you can generate purl fabrics. So, in V-bed machines also, nowadays you can actually make technical back and front on the V-bed machines, **(Video Ends: 39:45)** because of the needle transfer functions is there.

So, here you can see, on the first bed, you have the needle holding all the technical back loops. Then needle rises further. The loop is actually slides on the stem part. Then, the other needle is actually rising from the other bed. It is passing through the jack. And through the jack, in this process, it is actually holding the old loop. And in this way, it catches the old loops. And this, the first bed loops actually descends.

This is the process, how the loop from one bed is actually transferred to the other bed. So, you can create, once the loop is transferred to the other bed, you can do the knitting, you can make one course which is entirely technical front. Then, from this needle, you can transfer all the loops to other needles. That needle will again create another course of loops. So, purl fabric is now being also formed on V-bed machines, because of loop transfer functions which is possible on the machine. Now, let's come to the last category of fabric which is the interlock fabrics.

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You have heard this interlock name, especially in double jersey circular knitting machine where interlock machines are there, where the needles are actually facing each other. The cylinder needles and dial needles are facing each other. So, on that machine, usually you make a kind of fabric structure which is different than rib as well as purl. Actually, it makes the interlock fabric structure. Let's see what do you mean by interlock.

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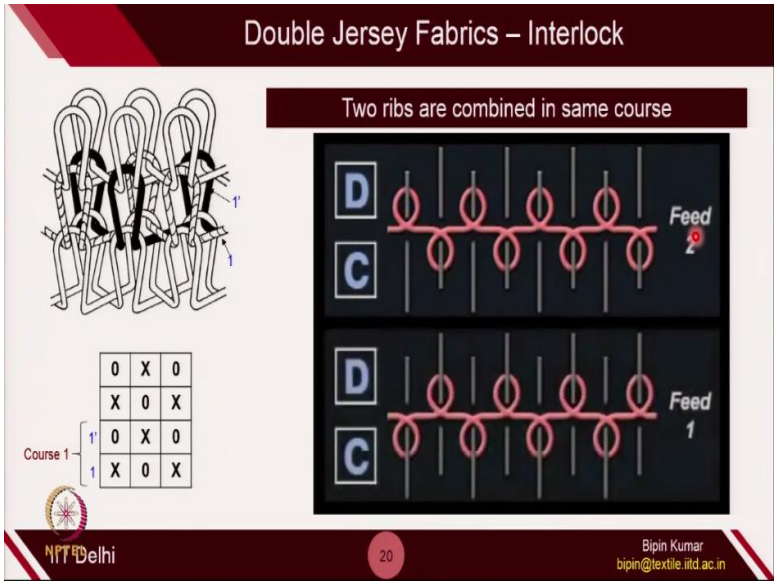

(Video Starts: 41:29) In interlock fabric is structure, actually 2 ribs are combined in the same course. So, if you carefully see the black color yarn, the 2 loops are technical back and the middle column loops are technical front, from the black yarn. But the white or the shaded yarn, if you see this shaded yarn, they are making technical front. And the middle column is making technical back.

So, the feeders **(Video Ends: 42:01)** are actually changed because we have seen how the needles are facing each other. So, at a certain time, all short butt needles of both the beds are operating. And in other time, all the long butt needles of both the beds are operating. And the feeders of all the butt, all different butt needles are different. Because of that, in the same course, different types of loops are generated.

So, the first course, you can see, a rib is generated; cross, 0, cross. This is a rib construction. In the second position, on both the beds, you have the opposite tendency of rib construction. So, these 2 rib constructions are actually created because of 2 feeding nature of the yarn. And in the course 1, you create actually 2 ribs which are intermeshing with each other. So, here is a small animation, you can see **(Video Starts: 42:54)** how the fabric is being created.

So, you can see how, only alternating needles of both the beds are operating. So, in first case, you are creating loops by alternating needles from both the beds. And in another feeding position, you are creating another rib constructions from other set of the needles. **(Video Ends: 43:17)** So, now you can see, this is the, actually position of short butt needles and long butt needles.

So, in first feeding position, all long butt needles are operating and they are making loops, okay, in first feeding position. In feeding poison 2, all short butt needles are feeding. So, in the same course, 2 types of feeding has been taking place simultaneously. And because of that, 2 ribs are getting intermeshed with each other. And a kind of interlock fabric is generated.

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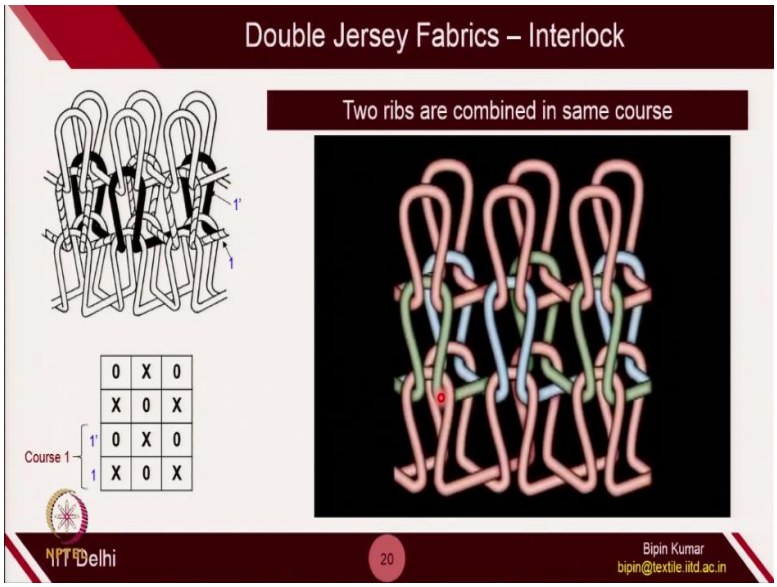

So, you can see here. So, in the first course, long butt needles are making all blue one, which is again a rib construction, 1 cross 1. Once that is done, then it is making the green loops of rib construction by short butt needles. And both this process are taking place simultaneously. Only the feeding is different. So, you have also seen the, how the cam was operating. There was 2 cam track for short butt needles as well as long butt needles.

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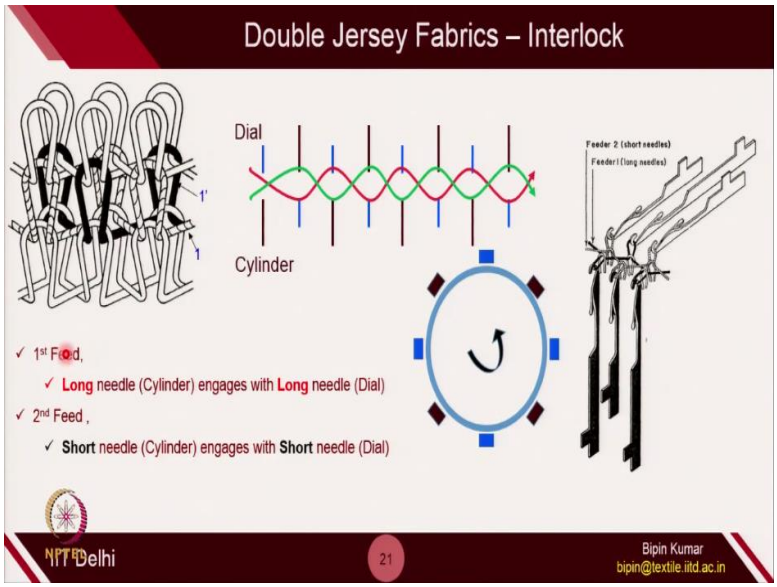

So, if you see the black color yarn, this is feed 2, all long butt needles of cylinder as well as dial. So, it is making a rib construction. So, first feed, all long butt needles catched from both the beds. And in second feed, all short butt needles are catched. So, all long butt needles; so first, all feeders in even positions, they are doing knitting and creating a 1 cross 1 rib. And after that, all short butt needles are creating 1 cross 1 rib. And these 2 ribs are actually intermeshed with each other. And this structure is basically different from rib construction. And this is called interlock fabric.

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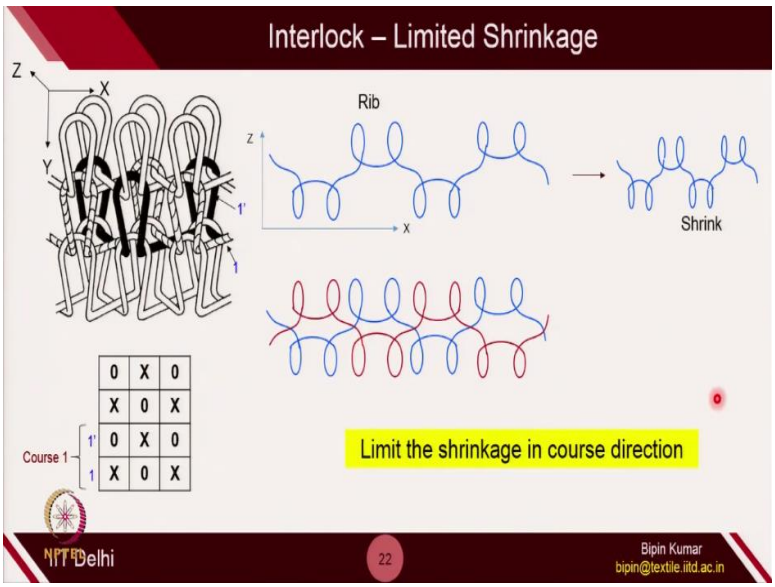

If you see interlock fabric carefully and if you see the projection of one of the rib; for example, if I am taking the projection of the first rib, the projection in z-x plane is look like this. If you go back to earlier slides, you will able to see the projection of earlier ribs constructions. If you relax this rib construction, it will shrink. But in case of interlock fabric, you have rib construction, the projection look like this, by one feed, by long butt needles.

Then another rib is actually intermeshing here. So, because of that, there is no allowance given for the loops to shrink. So, this is why interlock fabric is much more stable. So, the moment you make the interlock fabric from the machine, will not absorb too much shrinkers in width direction or in course direction compared to rib constructions, because of the nature of intermeshing. So, here is the basic characteristics of interlock constructions.

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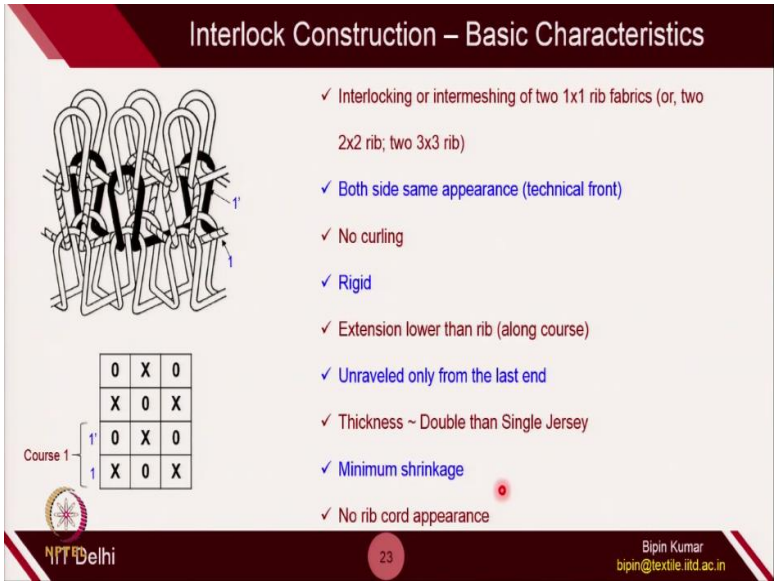

It is actually created by intermeshing 2 ribs. That rib could be 1 cross 1, 2 cross 2, 3 cross 3, depending on what type of constructions you want to make. It has both side same appearance. Especially, it will look technical front on both the sides. It does not curl; again, the same argument, because of the nature of the rib construction. It is comparatively very rigid, because ribs are intermeshed with each other.

And it does not shrink; the fabric remain very stable. Extension is much lower than rib, because of the intermeshing of ribs. The rib, each rib could not able to shrink in course direction. So, that's why, in course direction, it cannot be extend. Unravelling: Since it has the rib construction on the bottom, so you cannot unravel from the first course, only it can unravel from the last course or the top most course from the machine.

Thickness: It is double than the single jersey structure, because there is 2 loops which is facing each other. It has minimum shrinkage compared to all double jersey constructions, including plain, rib and interlock. Interlock is the more stable one, because it does not shrink. There is no rib cord appearance you will observe on the fabric. Because, if you see in the rib construction, there was a vertical lines separating 2 columns; but here, you will not observe those type of appearance. So, this is how interlock construction is different.

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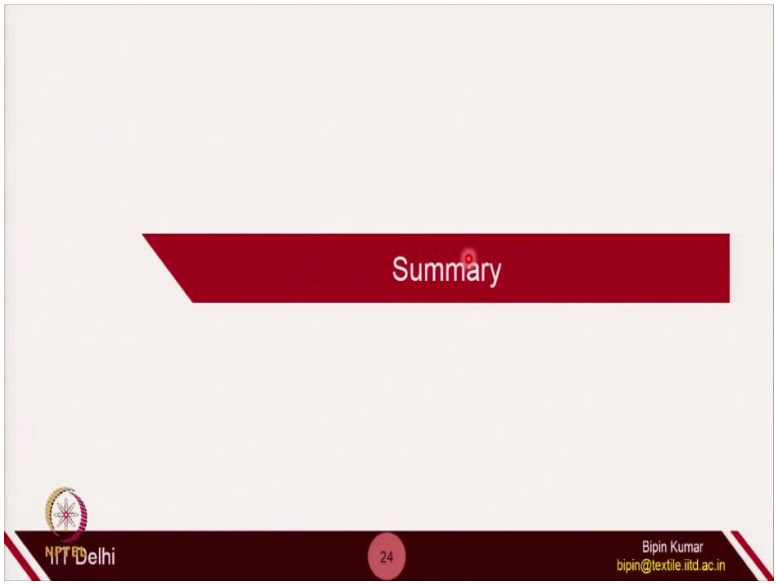

Now, let's summarize these 4 constructions. So, if you see, any weft knitted constructions, the platform on which loops are being generated, they belongs to either of these 4 construction.

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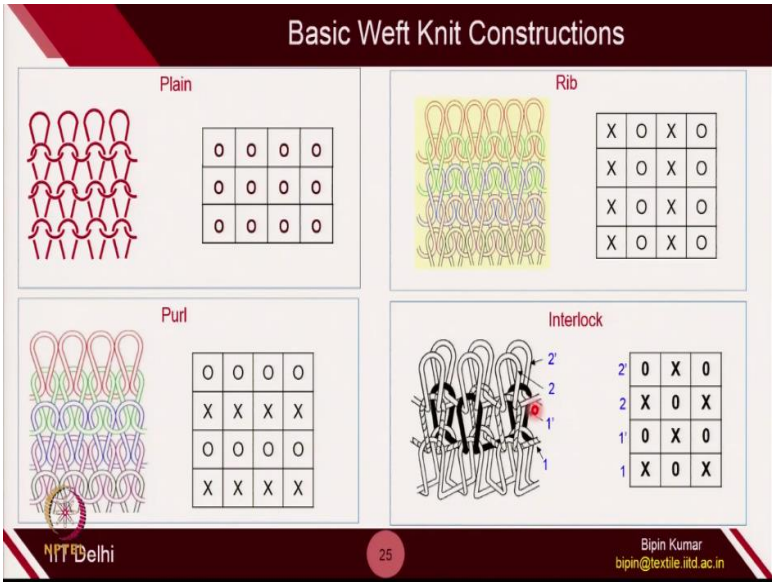

One is plain, where you have technical front or back. The another one is rib, where you have along the course, technical front and back. Then you have purl in which alternating course are different. Then you have interlock, where 2 ribs are intermeshed each other, because of engaging long butt needles from both the bed and engaging short butt needles from both the bed. So, out of these 4 constructions, each constructions has its own characteristics which is summarized here.

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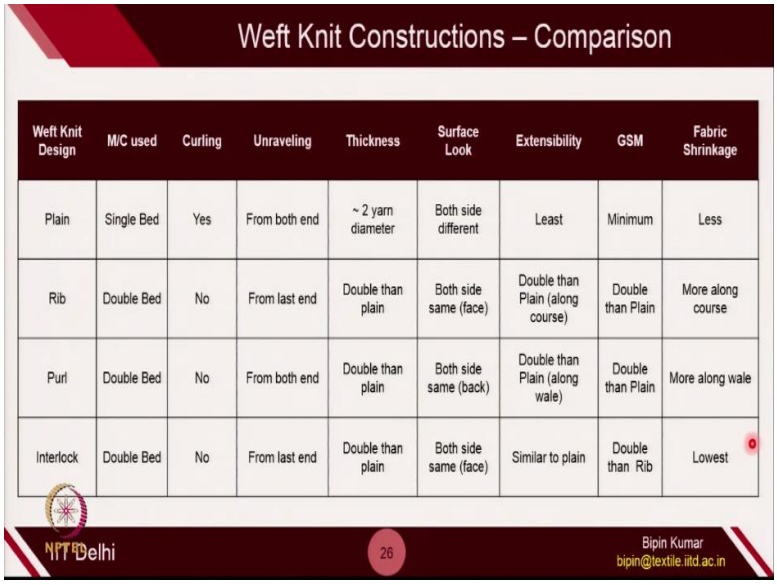

So, if you see plain, rib, purl, interlock; they are made by different technologies. For example, plain is made by single bed; rib is made by double bed; purl, interlock, they all are made by double bed. If you see the curling nature, only plain curls, but other construction does not curls. If you see the unravelling nature, plain can be unravelled from both end. In double jersey, purl can be unravelled from both ends.

But rib and interlock, they can only unravel from the last course or last end. They cannot be unravelled from the first course which you knit on the machine. If you see the thickness, plain has the lowest thickness, 2 times yarn diameter. Rib is having double thickness than plain. It means, 4 times yarn diameter. Purl also, 4 times yarn diameter. Interlock also, 4 times yarn diameter.

Surface look: If you see plain fabric, the looks are different. Technical back and front, they looks different. But if you see rib, purl and interlock, the surface look similar. So, on rib, only the face loops are visible. With a rib cord, a vertical lines will be separating these 2 columns. In purl, you will see technical back side loops on both the surface. And in interlock, again you will seeing the face side.

If you see the extensibility, plain is the least extensible in course and wales direction. Rib is extremely extensible in course direction. Similar extension in wales direction compared to plain. If you see, purl has double extension in wale direction, because it shrinks in lengthwise direction. If you see interlock, it is similar to plain, more stable in double jersey category, because of the intermeshing of rib.

GSM: If you see the weight which is gram per square meter, the plain is the minimum GSM. Rib is 2 times almost double than plain. Purl is also double than plain. Interlock is double than rib, because 2 ribs are combined together. Almost this is some how, the weight is different. In shrinkage also, plain will also shrink, once you take out the fabric from the machine. But rib and purl are the 2 constructions which shrink too much. But interlock is much more stable, it does not allow fabrics to shrink once you take out from the machine.

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So, this is how this single and double jersey constructions are so important, their characteristics are important, their nature are different. So, whenever you are making any garment, at what location, what designs should be suitable, it will depend on the construction and its nature. So, if you see the edges, should not curl, it should not unravel. That's why double jersey construction, especially rib is used in edges.

If you see the main body, you can go for single jersey as well as double jersey construction depending on the look and depending on the comfort. So, this is how these 4 platform of knit constructions are defined and is in practice across the world. So, we are finishing here about the knitting platform. From the next class, we are going further inside the structure, how even in any one of these platform, in double jersey or single jersey, we can change the loop shape and loop architecture.

So, in the next class, we are going to know about different type of structural elements, which is loop, tuck and miss. So, stay tuned. I catch you later. Thank you.