Science and Technology of Weft and Warp Knitting
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Module - 5
Lecture - 22
Fabric Analysis - Influence of Float and Tuck Stitches

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Welcome participants, to lecture number 3. In this, I have chosen a small topic on how we can control the fabric structure using float and tuck stitches. So, in this particular lecture, I am going to show you some fabric samples where we have created a pattern of float and tuck stitches along the courses. And then, we will do the analysis. We will check how the GSM, thread densities, loop length will change in the fabric.

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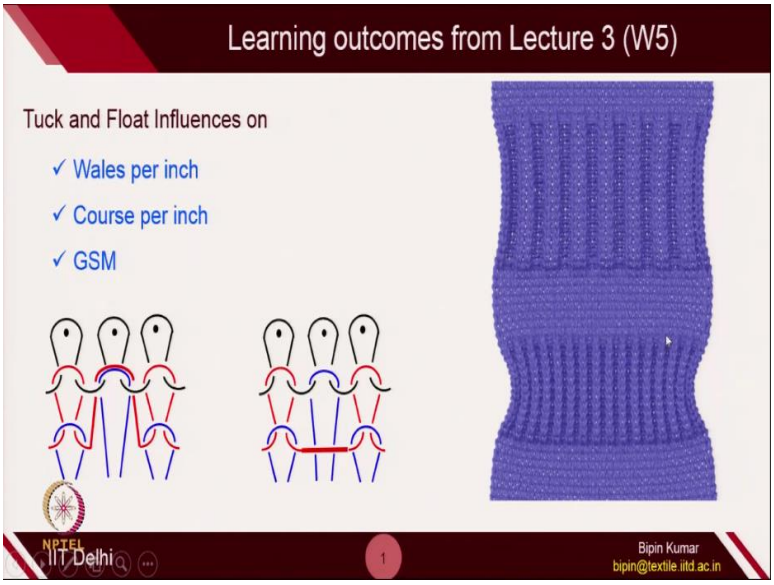

So, let's see what is actually tuck and loop stitches and float stitches. So, in tuck, you have already seen, you have 2 intermeshing points missing. And the needle catches the new yarn along with the old loop. In float, needle carries the old loop, but do not catches the new yarn. This is how you created float stitches. In last lecture, I also shown you some of the fabric samples where the width was changing, the structure was changing, the appearance was changing.

So here, we are going to analyze how because of these type of stitches, it changes the fabric appearance and properties. We will be focusing mainly on the fabrics that was created on V-bed, which is there in our lab. And we selectively control tuck and float using clearing cam and raising cam setting.

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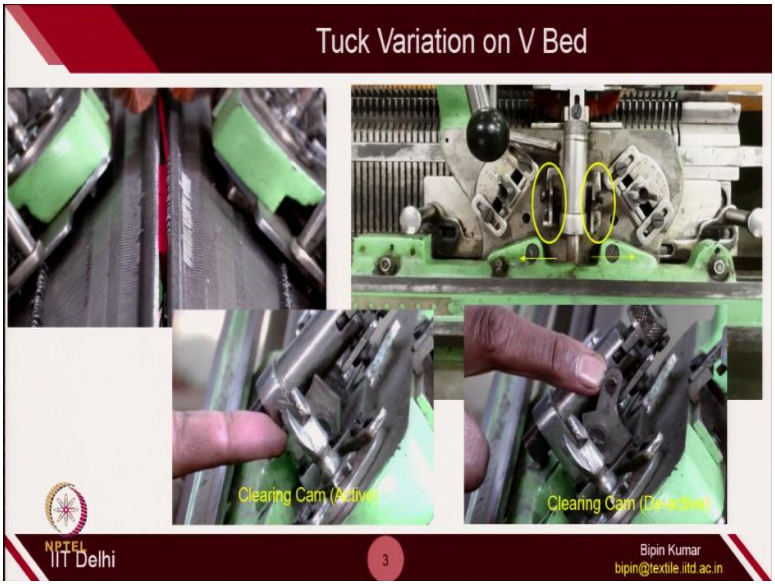

So, this is the machine. And you have, this indicates the position of clearing cam setting. When the carrier is moving from left to right, you can raise the clearing cam from one side to other side. And when the carrier is moving from right to left, you can use this clearing cam to control the clearing cam setting. So, this is the actual knob. So, if you see from the other side, this is how it will look.

So, this is the position where the clearing cam is an active. And this is the position the clearing cam is in deactive position. So, this petition indicates, when you press like this, the metallic bar, the clearing cam go inside the platform. And in that case, the needle butt will not engage with the cam profile.

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So, this is how it works. So, **(Video Starts: 02:40)** the moment you press it from one side to other side, you basically suppress the clearing cam. And then, you can run the machine for. This is only for one direction on one bed. So, similarly, you have 4 clearing cam setting. 2 for each bed. For left to right direction and right to left direction. And similarly, for the other carrier, on opposite bed you have 2 cam settings.

So, there are total 4 cam setting available on V-bed machine. And clearing cam is the position where you can play to control the tuck stitches. So here, some of the loops you can see. There are 2 loops has been there on one of the bed, **(Video Ends: 03:18)** while the other bed is having just 1 loops.

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So, for float stitch, raising cam has to be deactivated. So, this is the location. You can push this metallic bar inside to make float stitches.

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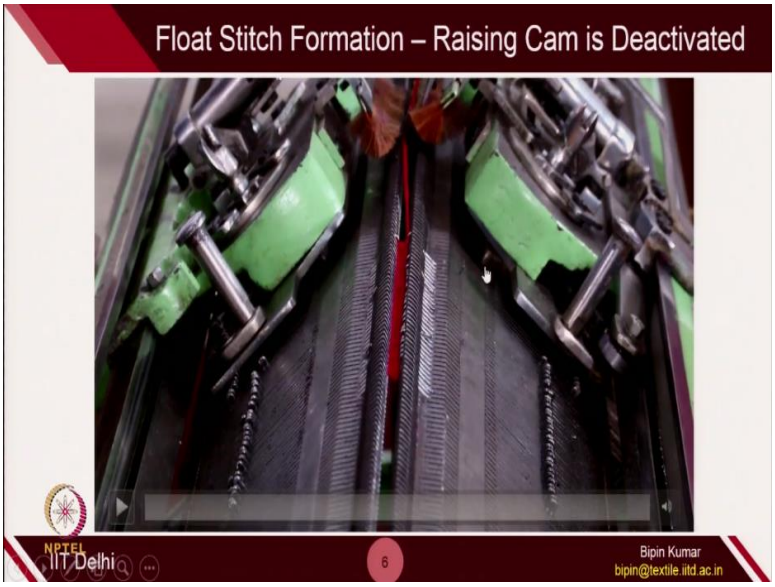

So, this is how I do. So, you have 4 float stitches, 2 for each bed. So, these 2 are operational, when you are moving the carrier from one side to other side. When you are reversing the direction of carrier, the opposite 2 cams raising cams will operate. So, at this moment, in this video, **(Video Starts: 03:54)** I am pushing inside. So, in that case, I am making sure the raising cam has suppressed inside.

So, in that case, you can see, no needles has been selected on this bed. Only this needles on opposite bed has been selected. Because, in that, the raising cam has been still active. But when, once I am reversing the path, you can see, both the needles of the beds has been

selected. So, only one side, you can see, only one side the cam has been deactivated; raising cam has been deactivated. But for the opposite side, the raising cam has not **(Video Ends: 04:28)** been deactivated. This is how you create float stitches.

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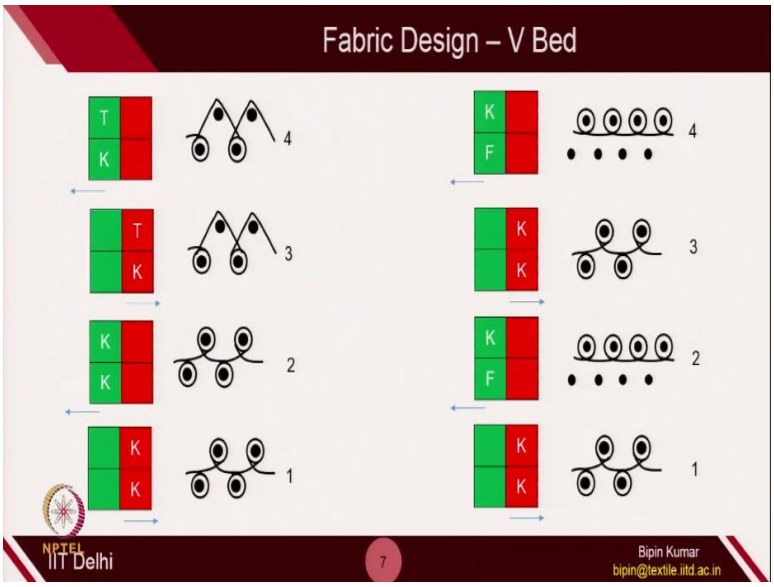

So, we can have different designs of the float. But, in this lecture, I am going to focus mainly on some specific designs, which is mainly popular in tuck category and also in float categories. So, in tuck categories, we have cardigan designs, double cardigan, half cardigan, full cardigan, double half cardigan, which belongs to tuck categories. In float, you have Milano, alternating half Milano, rib, rib purl, Milano rib.

So, these are some common technical names, which you will find in the industries. If you follow the notations only, then you do not need to remember these names. Simply, just understood what exactly what are the pattern or the setting you have done on the machines to create the courses in some sequence. So, let's see some of these fabric samples. I have these samples with me.

And I am going to show you these designs as well. Obviously, in carrying the tuck and float, there are unlimited **(Video Starts: 05:40)** numbers or unlimited possibilities that can be there on the machine. So, for example, I am just giving a simple hint. I have already given this indications in the last class also. Like, you can play each section, you can change the cam setting of each section and you can create different nature of stitches on the fabric surface.

Because of that, you can see how the structure will look like this. For example, if you see this particular section, 3 tuck has been created in alternating courses. So, let me give you some of the notation for this particular section of the fabrics. So, to create this particular section of the fabric: So, in the first course, I created rib. In second course, I created tuck on the back bed. In third course also, I created tuck on the back bed.

In fourth course also, I created tuck on the back bed. So, more tuck consecutively, actually, it will result in higher fabric width, which I am going to show you in few minutes. So, you can see clearly, how much the width has increased. Because, you have created 3 consecutively tuck on the same needles. Because of that, the legs become open. And you can see, there is a bigger held loop.

If you carefully see, the loop is much, much bigger. So, if you see individual loops, this is much, much bigger. Compared to the loops, if you see here, which is the normal rib design. The loop is much, much smaller. But, here you can see, this is a clearly a bigger loop you can observe. So, this is much, much bigger held loop. And this is normal rib loop on the, on both the sides.

So, if you carefully see how the loops will be there, especially in this needle. So, if you see this needle, it will be having loop like this. In the second course, I am just focusing on 1 needle. It will be catching the same old loop. And then, it will be taking one float. And then, in the third course, the same needle will be still catching the old loop; and then 2 tuck. So, these are the tuck.

In the fourth course also, the held loop will be still there in the needle head. And then, you will be having 3 tuck together on the same needle. In the fifth course, basically, then you are making the rib. It means, all these loops which was there on the needle, it will be released in the next course. So, this is how you will create a new loop. And all these 4; and as well as the bigger loops will come like this.

So, I have also, in one of the fabric notations, you might see, there was 3 tuck loop. And then, one loop was created on the same needle. So, this was the sequence of needle in this particular fabric. So, starting from simple loop, then this is held loop. Then, held loop is

getting bigger and bigger, because you are increasing number of tuck. And finally, 3 tuck and 1 held loop will be released in the fifth course; when it will create a rib design.

So, that needle will release 3 tuck and old loop. So, this is how you can see, how the structure is disturbed. If you see other part also, I have changed the design. So, designs are unlimited, let's focus on some of the common market designs which is popular **(Video Ends: 10:28)** in sweaters and some of the t-shirts which you are wearing. So, these designs belongs to cardigan and half cardigan design. **(Video Starts: 10:40)**

So, these are the designs which you will find more popular in the market. So, one belong to half cardigan design and full cardigan designs. So, if you see the movement of yarn; so, in the first course, all are knitting. So, in the first course, all are knitting. I hope you know the fabric notation. So, in the first course, all beds are knitting. So, you can see here, this is the front bed, technical front; then back; technical front; then back; then technical front.

So, this is how it is knitting. So, in the second course, if you see the black color. So basically, this is making tuck; and then, this is loop; then again, tuck; then loop; then tuck. Okay. So, basically, front bed needles are making tuck and back bed needles are making loops in the second course, if you follow the path of black yarn. So, this is tuck. You can see, it is there with the head.

So, this is tuck. And then, if you see this one, this is a loop technical back loop. So, like this. Then, if you see third column, this is again tuck. And then, if you see fourth column, again loop. And then, this is again tuck, loop, tuck, loop. So, what you can observe here is; in first course, both beds are knitting; in second course, front bed is making tuck, back bed is making loop. Okay.

In full cardigan, if you see, if you carefully see, in full cardigan, in the first course, if you carefully see, this is technical front, this is loop, then tuck, then loop, then tuck, then loop, tuck. So, the front bed is making loop, while if you see the back bed needles, this one is making tuck. Okay. So, this is tuck. Then if you go for third loop in the course, this is making technical front, then tuck, technical front, then tuck, technical front.

So, this is how it is doing. So, in half cardigan, both loops, but in full cardigan, one is making loop, other is making tuck. In the second course, let's see second course, how it is changing. So, in the second course, this is the black color yarn which you can see. So, the first one is making tuck. So, the black one, the head is not visible actually, but you can see the legs are open.

And it is on the head side. So naturally, this become tuck on the front bed. Then, if you see this black one, this is making back loop on the back bed, because it is on the back side. Then, again this is tuck. This is on the tuck side. You can see here, this is the front bed needle. Then again, back needle. Then again, tuck; and then, like this. So, the only difference you can see in half cardigan is, the front bed needles is making loop and tuck alternatively.

But in full cardigan, both front and back needles are making tuck and loop alternatively in courses. So, when front bed and making loop, back bed is making tuck. When front bed is making tuck, then back bed is making loops. So, this is how the fabric take place. And also you can see, the yarn path are different, So, this is the half cardigan and we call this as a full cardigan.

This these 2 designs are very popular in sweaters. Let me show you the fabric appearance. So, in reality, if you see, basically these are the 4 variation of tuck which is quite popular in tuck category. So, the first one is cardigan, which we call full cardigan also. So, front tuck, back loop, then front loop, back tuck. So, these are, it repeats in 2 courses. Then double cardigan, we are just repeating each of these courses twice.

So, that's why it is called double cardigan. So here, 2 tucks simultaneously and 2 loops on the back bed simultaneously in 2 courses. And then, in third course, the front is making loop, back is making tuck. In fourth courses, front is making again loop, back is making tuck. So, this is just, each of the course of cardigan is repeating twice. So, that's why, this is the repeat design of double cardigan.

In half cardigan, we have already seen, the front is making loops in both the courses, back is making loop and tuck in alternatingly courses. So, this is half cardigan. Double half cardigan, again we, if we repeat each of the courses 2 times, it become double half cardigan. So, this is

2 courses simultaneously. There, both beds are making loops. Here, 1 front bed is making loop, back is making tuck.

Here, front is making loop, back is making tuck. So, this is 4 designs: cardigan, double cardigan, half cardigan and double half cardigan. So, let's, let me show you some of these fabric. So, in a sequence, I created these 3 tuck designs. So, first of all, if you see the normal rib fabric. So, normal rib fabrics, the width is like this. But the moment you introduce tuck, so width increases. Okay.

So, because of that, number of wales which you can count in any of the tuck fabric will be much, much lower compared to a normal rib fabric. So, this is the rib fabric, 1 cross 1. And you can see how the tuck is changing the fabric width. So, this part of the fabric is basically the cardigan. So, if you see this part of the fabric, this is basically the cardigan. Okay. Now, if you see this part of the fabric.

So, I have given a marker here, so that, whenever I was changing, I put some marker, so that I can differentiate the fabric segment. So, this was basically the half cardigan; so, this part of the fabric. And when you go for this part, this is basically double half cardigan. So, this is the, if you go for this segment, so the repeat unit is this. So, this is how I created. This is double half cardigan.

And if you go below, this is half cardigan. And if you go even below, this is cardigan. So, you can see double, half cardigan and cardigan. It looks slightly different. If you reverse the fabric in the opposite side, then fabric of 3 designs will again look different. So, this is double half cardigan. And this is half cardigan. And now let's see, cardigan. So, this is cardigan, half cardigan and double half cardigan.

So, you can see how these 3 segments look different. So, double half cardigan, half cardigan, and cardigan. So, in double half cardigan, if you try to pull the yarn from one of the ends; so, please remember rib. Actually, in the rib fabrics, we can take out the yarn from the last course. So, this is the last course I created on the machine. So, I am going to show you, how you can see there are 2 ribs and 2 tucks if I take out the yarn for 4 courses consecutively.

So, let's try to first find out. So, if you see, the loops are being coming out from both the needle. So, this is naturally a rib. So, if you carefully see, the loops are coming out from both the sides. So, this is the rib course. Now, when, in the second course, you can see, only; so, this is the tuck. So, you can see here, only the loop is coming from one side. And other side, the tuck is there, which is not engaged.

So, you can observe, this is tuck. So, next course is tuck on the back bed, loop on the front bed. So, this is, you can see, this is the tuck. Now, let's go for the third course. Again, the similar nature. You can see here, loop is coming from the front bed, tuck from the back bed; front bed, back, tuck, loop, tuck; then this is loop, tuck; then after loop, then tuck; then loop, tuck. So, this is how; so, loop, tuck, loop, tuck, loop, tuck.

This is how you can create. So, the second course is also tuck on the back bed; 2 consecutive tuck on the back bed. Now, let's go for the fourth course, where you will see loops on the both the beds. So, can you see here? The loops are coming out from both the bed. Loops are coming out from both the beds, which was not there in case of tuck loops. So, you can see here, loops are coming out from both the beds.

So, you can see here. So, what you have observed here is: so basically, 2 rib and then 2 tuck. So, we started from here. So, first rib, then 2 tuck. Then again rib; then you will observe again rib; and then 2 tuck. So, this is how the fabric has been created in this. So, this is double half cardigan, this is half cardigan and this is cardigan. Now, let's see how the structural characteristics will change.

So, you know how you can take out the yarn. You can take out the yarn, you can measure the loop length, you can measure the thread density, you can measure the density of the fabric. So, everything you can measure for the cardigan. So, now let's see the wales per inch and course per inch of the fabric. So, wales per inch, if you measure; so, I used actually the machine which was used was 4 gauge machine.

And it was V-bed. Okay. So, I make all the samples on 4 gauge machine, V-bed. Okay. And the yarn count was around 192 tex, which I already showed you in double jersey fabric characterization. So, I expect you to please go and review this. So, for cardigan, the wale per

inch which was measured was 7. For double cardigan, it was measured 8; half cardigan, 6; and double half cardigan, 8.

So, you can see, more tuck consecutively, you can have more number of wales per inch. Okay. Course per inch: When you see the course per inch, it was 6, 6, 6 and 7. So, and if you see GSM of the fabric, it was observed, the cardigan was having 250 gram per meter square. This was 284 gram per meter square. This was 225 gram per meter square. And this was 310 gram per meter square.

So, this is what was observed after analysis of these fabrics. So, and if you see the loop length; so, if you see the cardigan, both the course are similar. So, if you take out the yarn of one course and divided by total number of needles, the loop length was 1.6 centimeter, for this particular course. If you go for double cardigan also, all the courses are almost similar. Only the nature of tuck and loop has been exchanged after 2 courses.

So, each courses, the loop length was observed same; so, 1.54 centimeter. In half cardigan, the loop length was observed 1.64 centimeter. And in double half cardigan, the loop length, the average loop length was observed for. So, in half cardigan also, if you see; this is the rib loop length where all the loops are in the rib shape. So, all are loops. So, 1.64 centimeter. But, if you see this particular course, so front are making loops, back are making tuck.

So naturally, the loop length of second course will be different than loop length of first course. So, average loop length, which includes the loop length of normal loop stitch and tuck stitch. And here only the loop stitch was there. So, the loop length was lower, 1.45 centimeter. Because, you know, in tuck, the foot is missing. So, that's why the loop length, if you take out the average loop length, including loop stitches and tuck stitches of this particular course; you will observe lesser loop length.

So, 1.45; here, 1.64. Again, if you go for double half cardigan, the loop length was 1.59 for loops on the both sides. For the tuck side, it was 1.46 centimeters. So, the key take which you can observe here is, rib loop length is bigger, tuck loop length is smaller, 1.46. And the next thing which you can observe here is, the amount of wales per inch. So, in cardigan, you have 7 wales per inch.

In double cardigan, you have 8. And in double half cardigan also 8. And half cardigan, it is 6. So, when you have more number of wales per inch, naturally the stitch density, which is the multiplication of wales inch and course per inch. So here, the total number of stitch density is 42 loops per inch square. Here, it 648; here, 36; here 56. So, naturally, if you see double half cardigan, more number of loops per unit area was present.

So, that's why the GSM is also observed very higher. So, this was the normal fabric analysis of tuck design. Depending on how you place the tuck stitches in the fabric, the nature of fabric will change. So, sometimes it can go for lower weight also. So, here you can see, half cardigan is the lowest weight, 225 gram per meter square. And double half cardigan is the highest weight, 310 gram per meter square.

So, this is how we do the analysis for tuck variation. Okay. So, in rib category, especially in float category, here, there are 4 basic fabric structure which is quite popular in the industry is, which is created by creating floats in the courses. So, the first category is half Milano. So, in half Milano, you have first course, both bed are knitting. In second course, only back bed is knitting, front is making floats.

So, and this fabric is repeating in 2 courses. Alternating half Milano: Here, first course is making knit, both knit. Second course, only back is knitting, front is remaining idle. In third course, it is knitting. In fourth course, only front are making loop, back is remaining idle. So, this is alternating half Milano, because both bed needles are making float, but alternatively. Milano rib, where you have rib in the first course.

Second course, you have float on the front bed and knit on the back bed. Second course, you have float on the back bed and knit on the front bed. So, both needles are making float, but alternatively. And there is additional one rib present. Rib ripple: Only one bed is making float. So here, both bed are making knit. Second course, only back is knitting, front is remaining idle. Third course, back is knitting, front is remaining idle.

So, Milano rib and rib ripple are difference in the sense, only one bed is operating in for the float condition. So, this fourth fabric is also present with me. So, I can show you how these fabrics looks. It is actually very difficult to observe the nature of this fabric. It is not easy by

looking that you can identify which one is half Milano, which one is alternating half Milano. But if you carefully take out the yarn, then you can follow this path.

So, this one is basically alternating half Milano. So, this segment is alternating half Milano, can see here. After that, this one is rib ripple. You can clearly see, there is some difference. So, this part is basically the rib ripple. And this one is alternating half Milano. This one is alternating half Milano. This one is rib ripple. And then, you can go further down. So, you can see, again this segment and this segment is different.

So, this segment is Milano rib. So, this is the Milano rib. So, you can see here Milano rib, how they are different. And this one is rib ripple. So, this segment is Milano rib and this segment is rib ripple. Okay. And the last part is half Milano. So, this is your half Milano. So, if you see this one; this one is Milano rib. And this one if you see, again you can carefully observe these 2 fabric surface looks different.

So, this is half Milano. So, if you reverse the fabric, again the it will look different. So, this is alternating half Milano. So, this is alternating half Milano. Then this is, this part of the fabric is rib ripple. And this part of the fabric is Milano rib. So, you can see this part and this part is slightly different. But the difference is not significant by eye. But, when you take out the yarn and then you will, if you note down the float notation, then you can observe these, each of these section of the fabric is different.

And this is half Milano. So, this is how we create this fabric. And now, let's see how the structure in terms of loop length, GSM are different for all of these fabrics. The Loop length of this particular course was 1.54 centimeter. This fabric was again created on the V-bed machine V-bed machine with 4 gauge. Okay. So, all 4 fabrics was created on the same machine with 4 gauge.

So, 1.54 centimeter for this loop length, for this particular course. If you go for this course, obviously, the front bed needles is not knitting. So, if you include the float length, if you include the loop length of floats, then the average loop length will become 0.8 for this particular. So, here I am counting the float length also. So, the total needles and the total length of the yarn, I take out the yarn from the course and divided by total number of needles.

So, this is how I observed the loop length of this. So, loop length in the float case is lower. But if you just observe the loop length of back bed, naturally this will be higher. So, this will become 1.6. So, which is higher than 1.54. So, but, since here the float is present. So, the average loop length which has both loops as well as floats, so the length of loop plus length of float from the back bed.

So, if you are counting both, then it is 0.8 centimeter average. And if you are just counting the loop length of the back beds, then it is 1.6 centimeter. So, it depends, how you want to explain. So, this is including float as a loop length. This is excluding float as a loop length. So, in this case also, if you go for alternating half Milano, this is 1.63 centimeter and this part is 0.77 centimeter with float.

And if you are just counting the loop length of back bed, ignoring the length from the float, then it is 1.54 centimeter; double off, just double off this. So, here in Milano rib and rib ripple also, you can measure the loop length. Now, let's go for wales per inch and course per inch and GSM. So, in case of wales per inch, the number of wales which was observed for half Milano was 6.5.

Alternating half Milano was 7. Then Milano rib was 7, rib ripple was 6.5. CPI was 7; and this was 7; then this was 7; this was 11, okay, course per inch. And if you see the GSM. GSM of this was for 457, 461.8, 480.29 and 505.65. So, this is how you observe the GSM. So, this is, you can clearly see, when you have 2 floats consecutively, you can see a major difference from Milano rib to rib ripple; so from 7 to 11.

So, when you have 2 floats consecutively on front bed in this particular needle, if you try to see why this 11 has come. So, it has the, the needle has made the loop here. But in this case, the needle is actually, held loop is there; this needle is not doing anything. Then you, if you go for this part, again the needle is not doing anything. So, the held loop is still there. And in the fourth course, this held loop is there.

So, you can see naturally, the held loop is under high tension when the machine is knitting. So, the moment you release the fabric, it will try to shrink the fabric in length direction. Because of that, number of courses will increase. So, this will try to relax. So, it will pull the

fabric in wale direction. So, the fabric you will observe lot of shrinkage in length direction because of head loop.

So, with this, I am going to end here. **(Video Ends: 39:13)** And I expect you to go through the influence of tuck and float with other literatures which is found online. And you can also design float and tuck variation on the machines and practice yourselves. So, thank you very much. So, we with this I am ending the structural analysis part of the fabric. From the next class, I am going to start the mechanical characterization of the analysis.

Like, once you make the fabric, how much you can stretch the fabric; what are the recovery aspect of the fabric; what is the shrinkage of the fabric. So, those type of analysis, I will be doing in the next lecture. So, with this, I am stopping here. Stay tuned. Enjoy knitting.