Science and Technology of Weft and Warp Knitting
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Lecture-40
Warp Knit Fabric Notation-Lapping Diagram and Lapping Plan

Welcome participants, now we are moving to lecture number 3 in week 9, today the topic is how you can denote warp knit fabric structure. So for the notation of a warp knit fabric structure, in practice lapping diagram and lapping plan of the guide bar is being followed. So similarly if you see the weft knitted structure you learn box diagram, point diagram and bar diagram. Because making the loops of any weft knitted structure or warp knitted structure is very very complicated.

So the notation plays a very very important role in understanding the fabric quickly, so in this I am going to explain you the lapping diagram and lapping plan through which you can denote most of the warp knitted fabric structures which you encountered in daily life. Before I move on let me quickly recap on the importance of swinging and shogging motion. Because the lapping diagram and lapping plan is basically described with the help of swinging and shogging motion primarily the underlap and overlap which is required to make the lapping diagram and lapping plan for the guide or guide bar.

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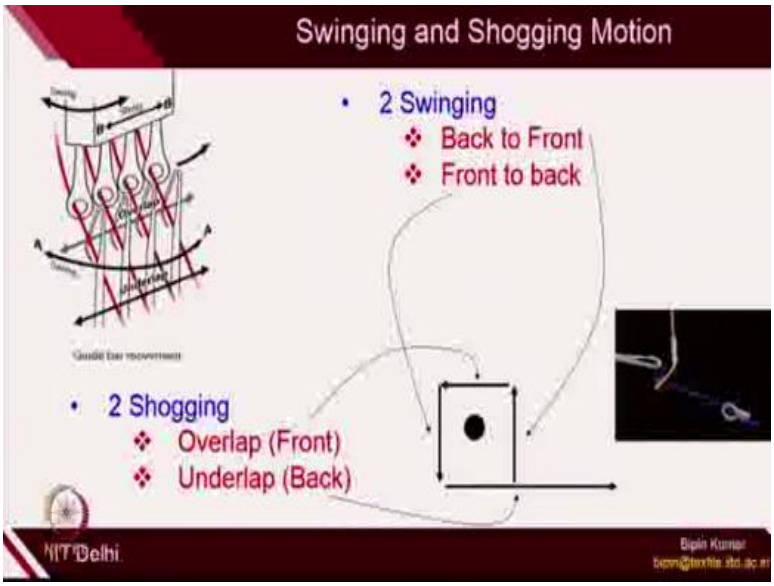

So this is the swinging and shogging motions which I explained in the first lecture of this week. There are 2 swinging motion one is from backside of the needle to the front side and the another one is from front to back side. And they are 2 shogging motions one is on the front side of the needle and the other one is on the back side of the needle. So for any course development each needle perform these 4 motions and that 4 motions can be explained by simple numbers.

And that number is more than sufficient to represent a fabric structure. So this is what you are going to learn today in this particular lectures, how you can express these 4 motion of a particular guide or the entire guide bar to describe the fabric structure. So in reality although the warp knit structure is very very complicated in terms of designing and all those aspects but in terms of fabric notation it is the most simplest one, so you will definitely enjoy the fabric notation.

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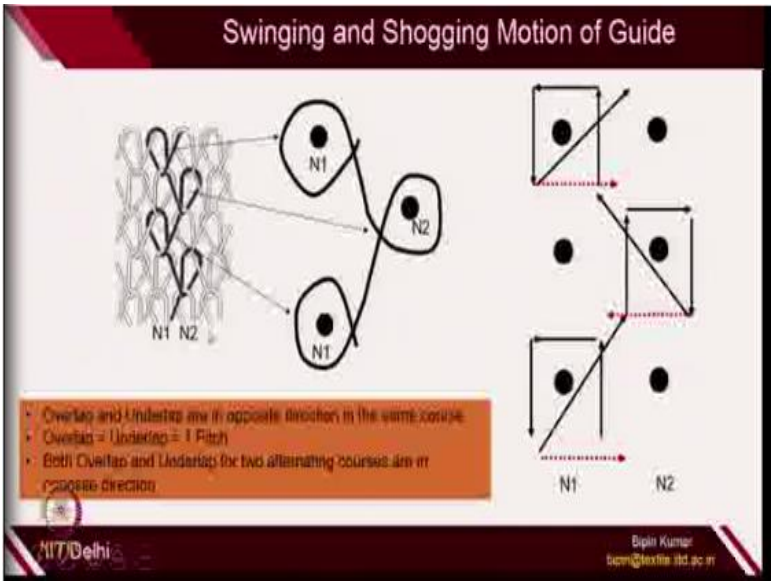

This is the swinging and shogging motion for this particular simple structure. So first the guide is coming to needle N1 then guide is for making the loop it follows 1 swinging then shogging front side, then swinging then shogging backside. So these 4 numbers we have to explain and after that it is moving to N2 and it again make the loop again swinging shogging, swinging shogging.

In the third course it is making loop again on N1 again you need to explain swinging shogging, swinging shogging. So you can easily understand that to describe the movement of guides it is

just the repetition of swinging and shogging. So if you can explain those repetition in terms of number you can express this fabricate structure. And also in terms of magnitude you have already seen that here the amount of overlap and underlap are in opposite directions.

So here the overlap and underlap are opposite direction in each course, the amount of overlap and underlap is equals to 1 pitch needle distance, both overlap and underlap in alternating course are different. So if I have to describe this particular structure, I need to describe the overlap and underlap movements for up to 2 courses because after 2 courses it is just repeating. So the third loop is repeating with the first loop, so if I can describe the fabric structure with the help of movement for 2 courses that will be more than sufficient to explain this fabric.

And since all the guides will have exactly the same movement, so even if you describe just one guide bar that is more than sufficient to describing the entire fabric structure.

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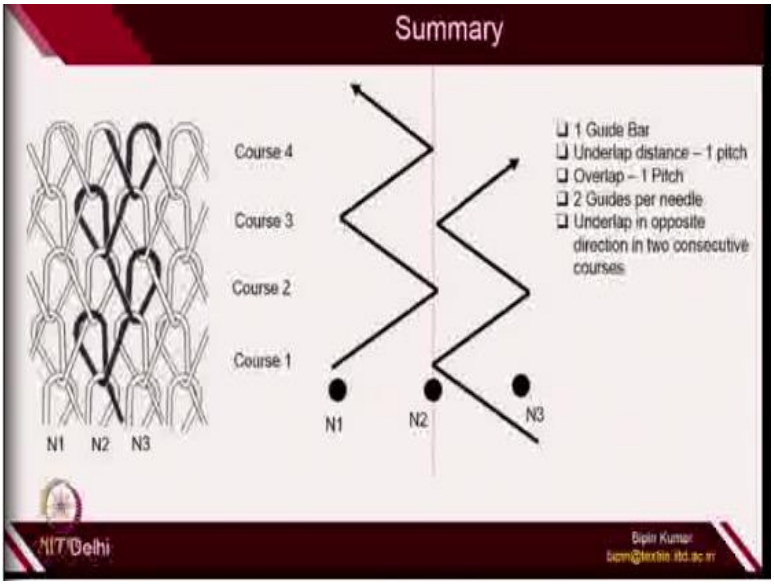

In the last class I also mentioned how the needles was interacting with different guides during loop formation. And for example this structure all the guides have the same movement, so they can be attached with the same guide bar. We have the underlap distance of one pitch, overlap distance in the front side is also for one pitch. We have 2 guides per needle because you can see in alternating courses the guides are changing for needle number 2, so they are 2 guides.

And underlaps are in opposite direction in alternating courses, so first time the guide is moving from left to right, then right to left, so this is how these are important.

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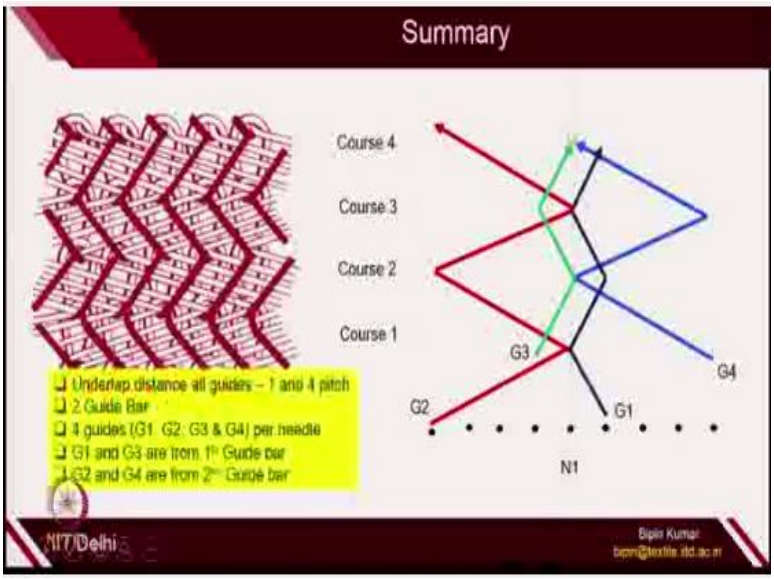

Similarly if you go for more complicated structure where 2 guides bar are used and each needle are interacting with 4 guides. So underlap distance of all guides are either 1 pitch or 4 pitch. So here this guide is having 1 pitch and this guide is having 4 pitch and since the underlap distance is different. So we need 2 guide bars and each needle is interacting with 4 guides during the fabric formation. And G1 and G3 if you see G1 and G3 the green one and this color the blue color purple blue they are the same movement, so they can be attached with the same guide bar.

And if you see the red one and the dark blue they have the same movement, so that can be attached with the different guide bar. So this is what we have learned in the previous lecture, so drawing this loops is really-really difficult. Instead of drawing these actual fabrics if we can simply draw these lines or if we can simply express the movement of overlap and underlap in terms of number that will be more than sufficient to explain this fabric structure.

So in warp knitted fabric notations we usually follow the movement of guides and we denote their overlap and underlap movements in terms of numbers. So this is how the fabric notation is described in warp knit structure.

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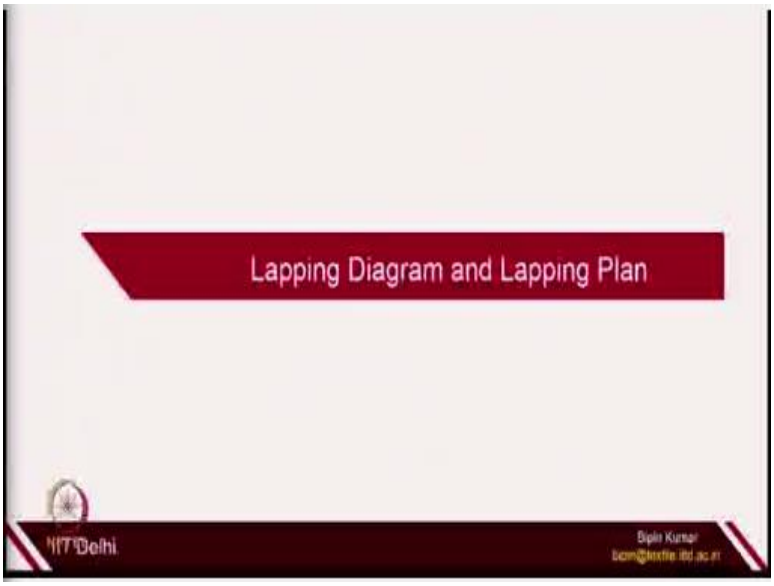

So those diagram and numbers are represented by lapping diagram and lapping plan. So for describing any fabric structure if you can describe it is lapping diagram which indicates how the guide bar is switching from one needle to other needle that is described by lapping diagram. And lapping plan is what is the magnitude in terms of number the guide bar is switching. So if you can follow these 2 diagrams then you can express any complicated structure related to warp knitted.

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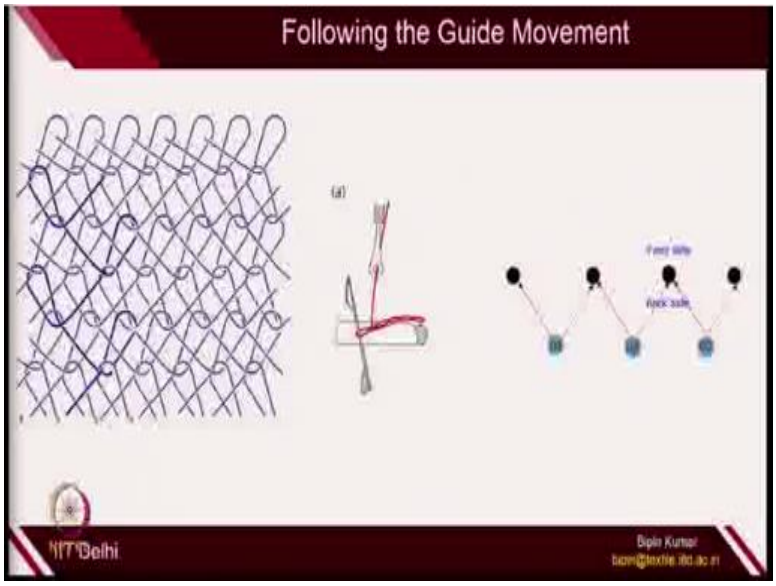

Let me show you some examples, for example if you see this particularly structures and carefully you can follow one of the movement of yarn. So if you see the dark one you can start from here it is first making loop this way then it is moving to the first column making loop. Then it is again

moving to the third column then again it is moving to the first column, so the movement of this guide is clearly visible in this fabric structure.

And the floating length is just one yarn, so you can easily say this is a single bar structure and in a single bar structure all guides will have the same movement. So if you can express the movement of one guide that will be more than sufficient to express this fabric structure. So this is the movement of one guide for a particular needle. So this is let's suppose the guide number 3 is providing yarn to this particular needle and in the next course it is providing yarn to the second needle ok.

So this is how in realities the guide bar actually switches position from one needle to other needle. So although here the guide are switching from one to third needle but in some simple fabric structure the guide is switching from one column to other column.

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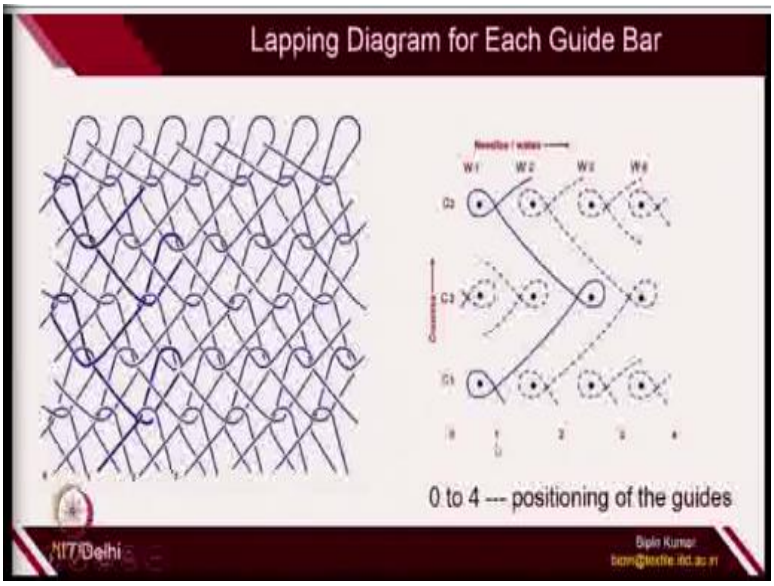

So this is what we have to explain, so this fabric can be represented by simple lapping diagram of each guide. So to describe the lapping diagram of each guide we have to first denote some numbers or some starting position which is expressed here. So on the left side of this column the position is 0, after first column the distance between these 2 columns are represented by number 1.

Then second column is starting, after finishing second column we have the number 2 then number 3 or number 4. So basically these 0, 1, 2, 3 and 4, this indicates the position of guides before making the course. And these are the needles which is denoted by dot and the guides are standing at the back side of the needle at their respective positions. So the first guide is standing on 0 position, second guide is standing on the first position, third guide is standing on the second position, fourth guide is standing on the third position and fifth guide is standing on the fourth position.

And 0 to 4 actually this indicates just the number on which the particular guide is located at the backside of the needle. So for example let's suppose I want to follow the movement of one of the guide which is located at number 1 position. So according to this fabric if you carefully see, so the guide number 1 which is located at this particular position which is between these 2 needles. It first supply yarns to this needle and then it is moving to the third needle, so if you see this particular fabric structure.

So first it makes loops on the first needle then it is making loop on the third needle in the second course after that it is again making loop on the first needle ok. So this is how the loops are being formed by guide number 1 which is located at this particular position ok. So this is called lapping diagram which just indicates how the individual guides are moving during fabric formation. So you can keep repeating these movements for other guides and then you can get almost the diagram like this.

So at this moment I need to explain only the movement of one particular guide which is shown by the actually dark line which is shown here, so this is the lapping diagram.

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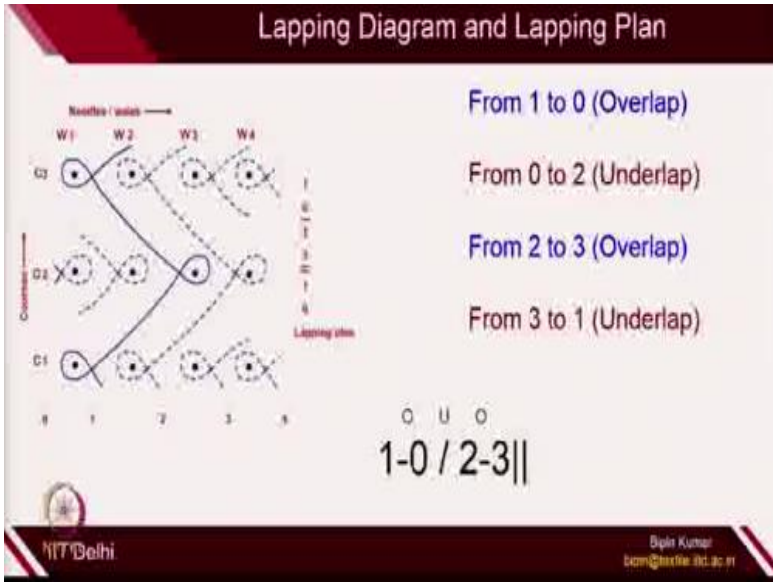

So if you see carefully the lapping diagram, that lapping diagram can be expressed by certain numbers which is called lapping plan. So following the movement of this particular position of guide, it is first swinging then shogging then going back and then again shogging. So this is what the guide is doing first from 1 to 0, so basically it is moving from 1 position to 0 position and providing the yarn, so this is nothing but overlap.

If you recollect overlap is always on the front side, so 1 to 0 is the overlap, after that from 0 position it is moving back side and reaching to second position ok. Because it has to provide yarn to the third needle, so from 0 to 2 from 0 to second position, so this is the 0 position and this is the second position. So from 0 it is reaching to second position which is nothing but the underlap, so underlap is at the back sides which you can show it from here.

After that once the needle reach to second position it is providing yarn to the this particular needle, so which is on the front side. So for providing the yarn the shogging is done from position number 2 to position number 3. So from position number 2 to position number 3 again you are doing overlap and after that you reach to the third position. And this is the third position on the right side of this particular needle, from the third position now you are going back to the first position which is again underlap.

So this lapping diagram of a particular guide can be expressed by these numbers which is 1-0, 2-3. So 1-0 is nothing but the overlap which is so distance between overlap the numbers is represented by dash and then you have the oblique which represent the underlap. So from 0 to 2 it indicates underlap, again from 2 to 3 it indicates overlap and after that 3 to 1, the fabric is reaching to the first position and then again that is repeating.

So once it reaches to the first position it is again repeating, so you do not have to express the same number. So in sequence the numbers will be repeated 1-0, 2-3, 1-0, 2-3 so just 4 digit is more than sufficient to describe the lapping plan for this lapping diagram. So 1 to 0 is the first overlap, 0 to 2 is the first underlap, then 2 to 3 is first overlap then after 3 obviously we know the same 4 digit numbers will be coming.

So 3 to 1 will be again underlap and with this the whole design is repeating in 2 courses. So this is the lapping diagram and lapping plan which is frequently used in denoting warp knitted structure and I am going to give you a lot of practice in this together.

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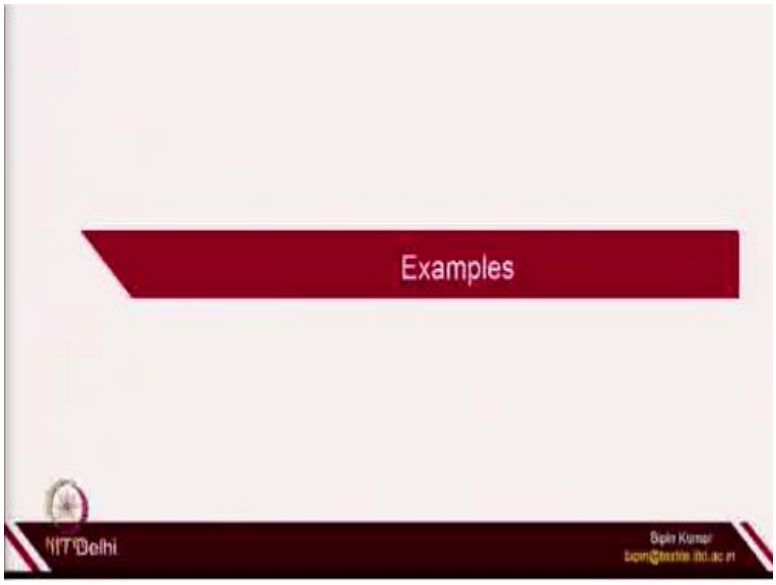

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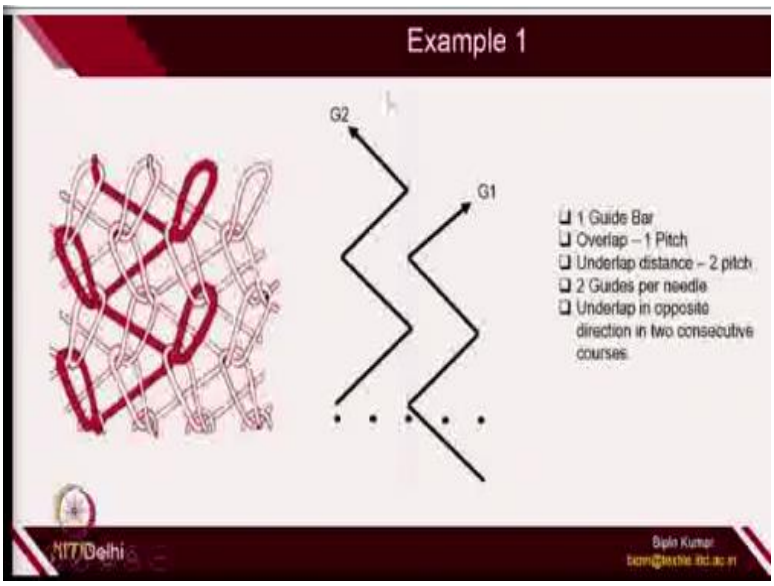

And there are some examples where the same fabrics which looks so complicated in terms of designing. But you can express this fabric by some digits or some lapping diagram that will be more than sufficient. So if you see this fabric you can clearly see there is just 1 movement of guide bar.

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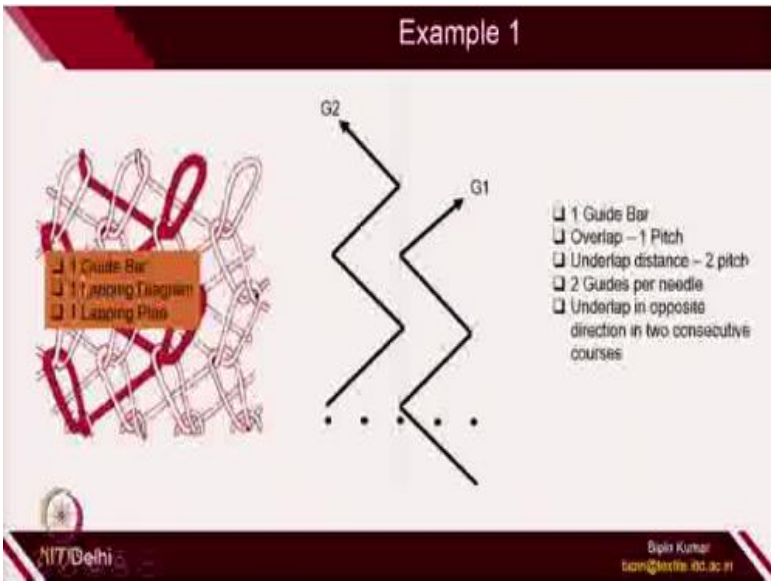

So 1 guide bar fabric, so we need 1 lapping diagram for 1 guide bar and 1 lapping plans so 4 digit numbers ok .

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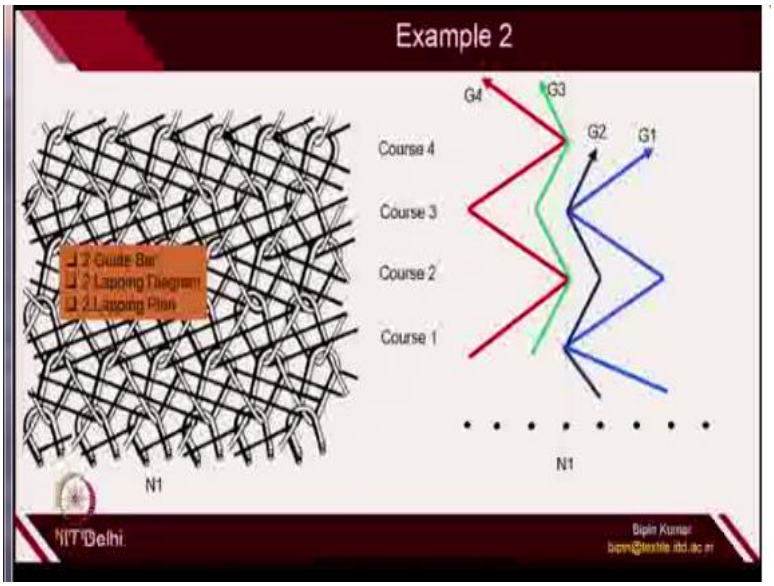

If you see this particular fabric, so you have 2 guide bar because we explained in the last class also. So for each guide bar we need to have 1 separate lapping diagram and for that lapping diagram I need to have separate lapping plans. So for describing this fabric I need to create 2 lapping diagram and 2 lapping plan.

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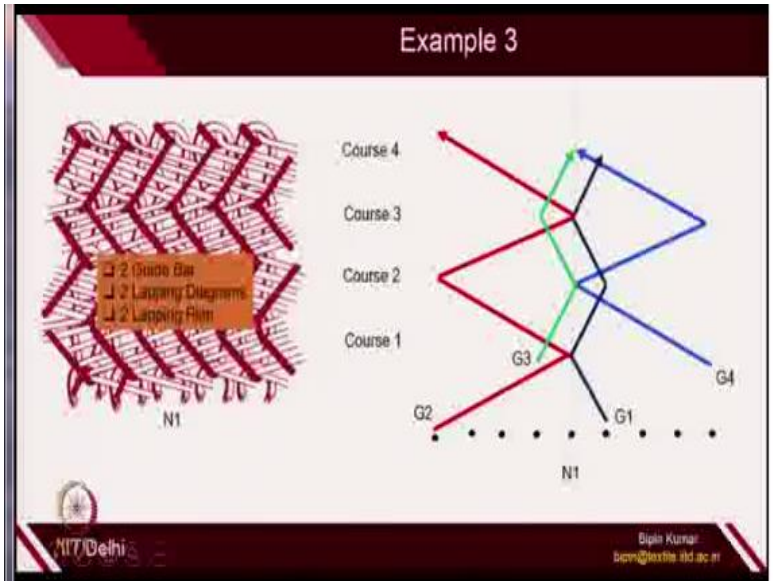

Similarly if you see this structure again a 2 bar structure, so 2 lapping diagrams and 2 lapping plan is needed to describe this fabric structures.

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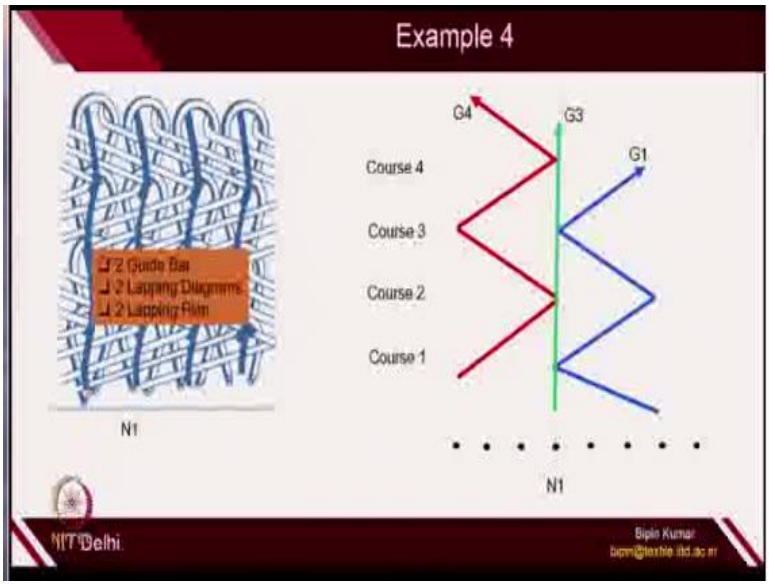

If you see this one again it is a 2 guide bar, 2 lapping diagrams and 2 lapping plans, so let's do some of the examples and practice the notation form.

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So notation is actually very very simple.

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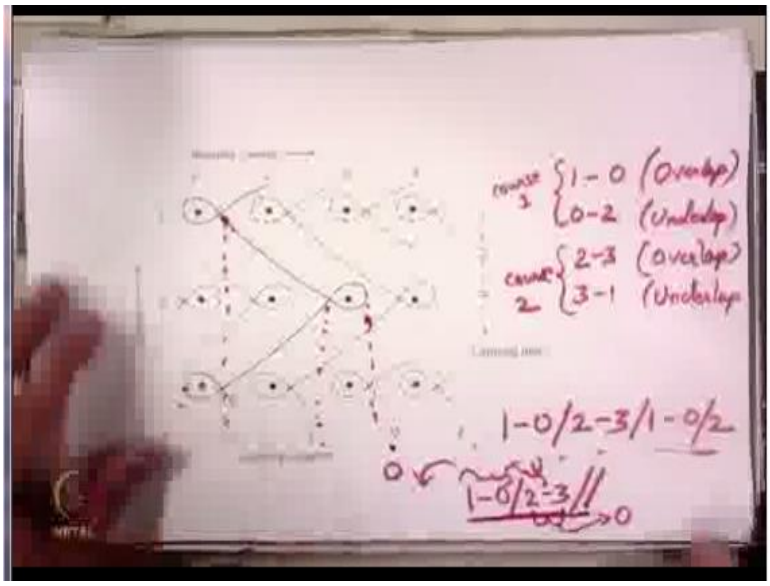

So the first thing you have to do is, you need to denote the position of guide bars ok, so once the position is decided. So we usually start from either 0 to 4 we start from either from the left side of the needles or right side of the needle. So in some books you will follow that the 0 is a starting from the right side and then in the increasing fashion towards left. But we will be following the simple one, we will be starting the position of guide from the left most to right most.

So the first position is 0 position which is the left side of this particular needle, second position is the first position which is between these 2 needles. After that third position of guide is second which is between these 2 needles after that the third position which is between these 2 needles. So once this is done and if the lapping diagram is known to you how the guide is moving then you can express this lapping diagram in terms of some numbers which is lapping plan.

So how these numbers are generated, so if you see if you follow the yarn path you are moving from backside of the needle towards front side ok. So you are moving from backside to the front side, so when you are moving you are changing the position from first to 0. So first to 0 you are changing the position and this is nothing but overlap ok, after 0 position now the guide bar is here and the backside of the needle ok.

So after 0 position you are moving to this position which is nothing but number 2 which is on the backside. So 0 to 2 position is underlap ok, so 1 overlap and 1 underlap is required for the

formation of first course, course number 1. So we started from here and we finished here then 1 course is done then after that once it reaches to second position then you can see the yarn is moving towards on the front side which is again overlap and the position is shifting from 2 to 3.

So 2 to 3 its nothing but overlap because it is on the front side ok, so 2 to 3 and now the guide is at this position which is nothing but at the third position. So, from the third position again it is following this part on the backside and then it is reaching on this position which is nothing but first position should 3 to 1. So this is again underlap this is course number 2 ok, so after finishing 2 course we reach to the same positions.

So we started from here we are ending also in the same position, so these digits is more than sufficient, so if you just sum up these digits. So 1 to 0 overlap after that for representing the underlap 0 to 2 this is underlap then 2 to 3 then again it will be reaching 3 to 1 underlap, then 1 to 0 overlap, then 0 to 2, so this will be just following. So what we can do is because 1-0, 2-3 is repeating, so our lapping plan will just be 1-0, 2-3 and we give a break.

So with just indicates it is repeating, so 1-0, 2-3, 1-0, 2-3, 1-0, 2-3, so if you see this lapping plan, so in this 1 to 0 it indicates overlap, 0 to 2 it indicates underlap and 2 to 3 it again indicates overlap ok. So in this way the whole fabric will be denoted by just 4 digit number.

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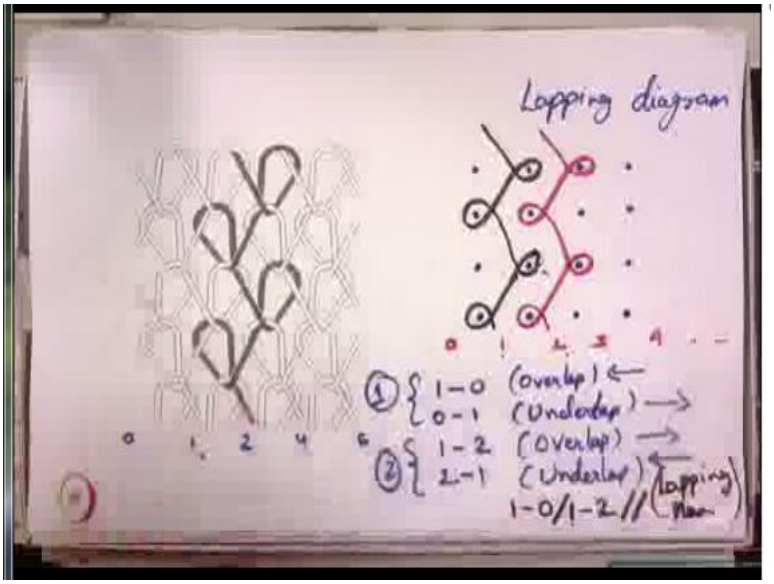

So this is the lapping diagram and lapping plan, now let's look at this particular fabric because we are looking at this fabric multiple times. So let's see how do we start, the first thing we need to denote the position, so the first position is 0 position, then second position, third position, fourth position, fifth position. So 0 indicate the first position of guide bar, first indicate the second position of guide bar, 2 indicates third position of guide bar.

So there are 4 columns, so you can just have the needles 4 needles and you have 4 position 0, 1, 2, 3, 4 bla bla bla ok. So to explain this fabric we need to just follow anyone yarn and that should be more than sufficient, so this is for one course let's make it some more courses because we need to create lapping diagram. You can choose any of these yarn ends for lapping diagram but let's follow the first one which is more easy to express.

So let's follow from the first position, so this is the movement of the yarn which is attached with the guide which is there on the first position. So first it is providing yarn to the this particular needle then it is providing yarn to the second needle, then again it is providing yarn to the first needle and then it is providing yarn to the second needle. So this is how it is repeating ok, if you follow this particular guide second guide.

So let me use different colors just for better understanding, so if you follow the black color yarn it is starting from second position and then it is giving loop to the second needle, then it is giving loop to the third needle, then it is giving loop to the second needle and then it is giving loop to the third needle ok. So this is how lapping diagram for each guides can be designed but naturally since all the guides have the same movement.

So no need to express so many diagrams because unnecessary it will become more complicate. We need to just express for one guide because all guides will have the same movements, so let's follow the notation for one guide which is the black one. So this particular diagram is called lapping diagram, now let's do the lapping plan. So for the lapping plan we start from the initial position of guide which is the first position, from first position it is moving to 0 position.

So this is how it is starting 1 to 0, so this is nothing but overlap, after doing overlap the position of guide is at 0 position, from 0 position it is moving to first positions it is coming to this position. So that it can provides yarn to second number needle, so 0 to 1 is nothing but underlap because after every overlap they must be underlap. So now this is first course ok, after reaching to first position now it is giving overlap doing overlap on the second needle from position number 1 to position number 2.

So from 1 to 2, so because the position now here is at this position which is between these 2 needles, so this is the first position and after that it is moving to the second number position ok. So 1 to 2 this is again overlap, so after that now the guide is coming to second number position, from second number position now it is reaching back to the first number position to provide yarn to the first needle, so 2 to 1 this is again underlap and this is course number 2.

Then course number 3 will be similar to course number 1, course number 4 will be similar to course number 2. So no need to explain and these numbers you can just write down in a sequence, so 1-0, 1-2 bla bla bla ok, so 1 to 0 is overlap, 0 to 1 is underlap, 1 to 2 is again overlap and then after 2 then the next digit will be 1 again, so 2 to 1 will be underlap. So this is how, this is called lapping plan ok.

So this the whole fabric can be represented either by lapping diagram or lapping plan. So in research paper or in practice you will be using either lapping plan or lapping diagram ok, one more interesting thing if you try to analyze more and more. So if you see here the overlap is from 1 to 0, so this is basically from left to right, so the direction of overlap is in this way, if you see 1 to 2 the direction is on the right side ok.

So in alternating courses the direction of overlap are different, if you see underlap here 0 to 1 right side and if you see here the direction is opposite ok. So directions are different, in the same course the direction of overlap and underlap are in opposite direction. So these are the some of the basic things which you can figure it out while making the lapping diagram.

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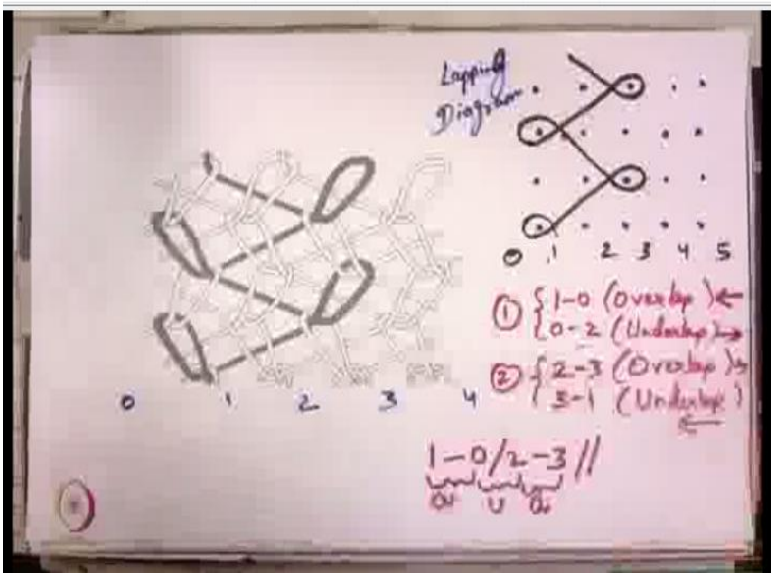

Let's do for the another one, this is also very very simple, so the first thing what you need to start it the moment you let suppose if you capture the fabric structure by zooming in microscope you can make this diagram and then you can go for lapping diagram and lapping plan. So to make the lapping diagram you need to first denote the position of guide bar, so 0, 1, 2, 3, 4, so 0 on the left side of first needle, 1 on the right side of the first needle and left side of the second needle.

So 1, 2, 3, 4, 5 and this will be the position of guide bar 0, 1, 2, 3, 4, 5 ok, so this the first course then this is course number 2, then this is course number 3 ok, and then this is course number 4 ok. So you can start following the path of the yarn, so the yarn is starting from first number position, then making the loop and then going to the third position needle. So this is how it is going, so from the first needle it is making loop.

Then going to the third needle in the second course, then again going to the first needle in third course and then it is going to the third needle in fourth course and this is how this lapping diagram is done. Similarly if you follow the white yarn of the second column it is doing the same thing ok. So but no need to describe for all the guides because all the guides will have exactly same movement.

So it is better to just express one and that it will be more than sufficient, so how you can note down with the help of number. So this is your lapping diagram, so lapping number will be from 1

to 0 this is overlap because you are moving from 1 to 0. Then from 0 to second position on the backside 0 to 2 this is underlap. So you finish course number 1 now you are making loop on course number 2 ok, so this is course number 2.

So course number 2 you are moving from second position the guide is moving from second position to third position. So second to third this is on the front side, so this will be overlap ok and from third position you are moving to first position, so third to 1 this is underlap ok, this is finishing course number 2. After finishing course number 2 the position of guide is first position, so this is the first position, so from the starting point we are reaching again to the starting point, so no need to describe again, so this will be more than sufficient.

So now you can simply write down these numbers in sequence, so first 1 is coming, then 0 is coming, after 0 your 2 is coming and then after 2, 3 is coming and then it is repeating. So 1 to 0 overlap, 0 to 2 underlap and 2 to 3 again overlap, then 3 to 1 will be underlap. So this is how you can describe, other thing which you can also see here 1 to 0 the overlap direction is on the left side ok, 0 to 2 it is right side and the magnitude is also different.

So this is 1 pitch, this is 2 pitch ok because underlap is more compared to overlap after that from 2 to 3 this is right side and 3 to 1 on the back side ok. So in alternating courses you can see overlap are changing directions, underlap are changing directions and in the same courses the magnitude is different. If you compare with this one the they are changing directions but the magnitudes were same, so 1 to 0, 0 to once magnitude were same, here magnitudes are different.

So because of that these 2 structure look different, so here one interesting thing which you can observe is that is a long floating length.

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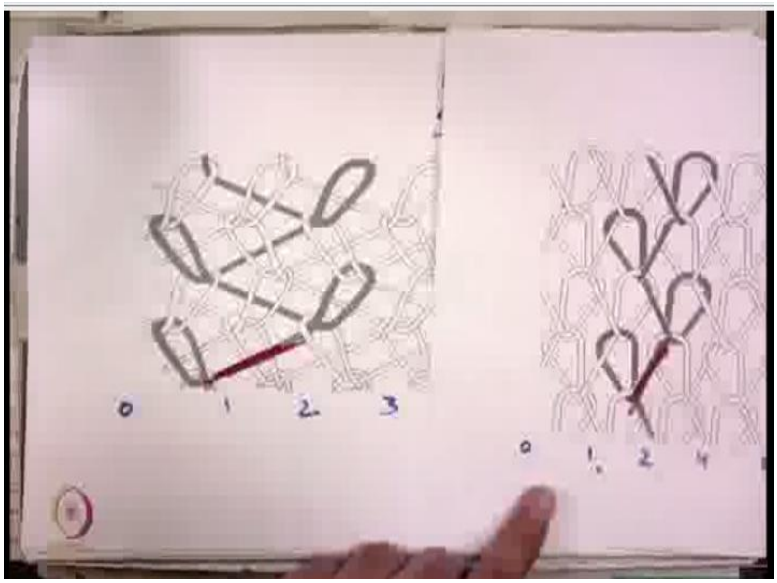

So you can see there is a long floating length this is smaller floating length ok, so that way the fabric structure will be different. So this is the lapping diagram and lapping plan for single bar structure.

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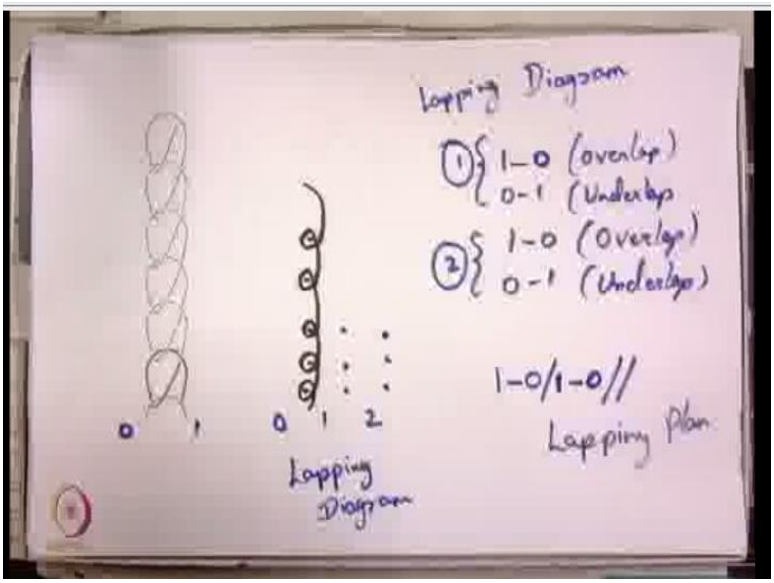

We can have more complicated also, for example this is another fabric having just providing yarn to the same column. So here if you follow the path of the yarn it is just providing yarn in the same needle, it is just providing yarn to the same needle. So if we follow the path of the yarn it is providing yarn to the same needle ok, so again you can write down 0 and 1, so 0, 1 then 2 position, so this is the lapping diagram and for this particular guide how the things will be moving.

So from 1 to 0 you are doing overlap and then 0 to 1 you are doing underlap ok, so 0 to 1 you are doing underlap. So after this position again you are doing overlap and then underlap, so 1 to 0 again overlap in the second course then 0 to 1 underlap, so this is course number 1, this is course number 2 ok. So 1 to 0, then 0 to 1 then again 1 to 0, then 0 to 1, then again 1 to 0, 0 to 1, so this is repeating so just put down in a sequence.

So 1 to 0, then 0 to 1, then 1 to 0 then double slash, so this is the lapping plan because 1-0, 1-0 is also repeating but if you just put 1-0 it will be just denoting underlap. So overlap will be missed, so better at least 4 digit numbers should be there for lapping plan, so this is lapping plan and this is lapping diagram. So in one of the structure which I showed you, where the needles were moving in the same direction the same guide bar was giving yarn to the same needle, so the structure is actually made by this.

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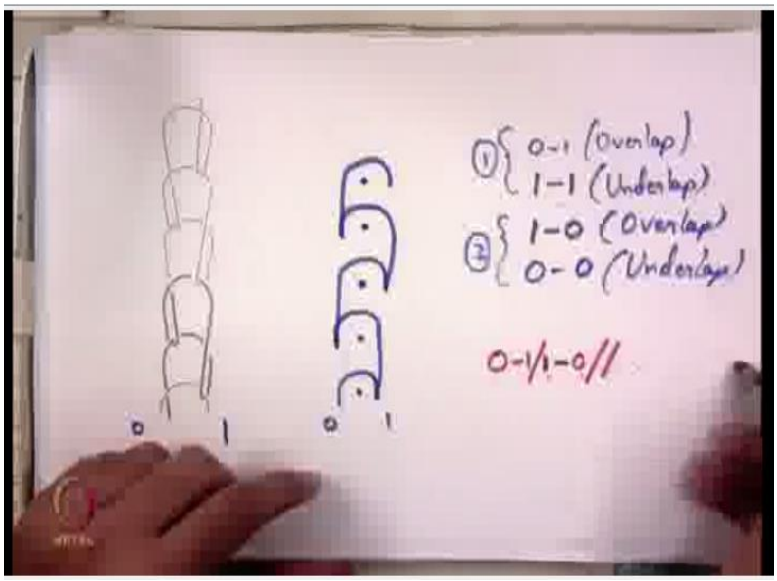

Now let's do another example, so if you follow here, so 0 position, 1 position and these are the needles in different courses. So the first thing is it is coming from 0 position then going to 1 position ok and then from 1 position then it is going to 0 position ok. And then from 0 position then it is going to 1 position and then 1 position it is going to 0 position. So this is how the loops are being formed ok, so this is 0 position, this is 1 position.

So if you want to describe the lapping plan, so you can simply write it down, so we started 0 to 1 is overlap, so 1 to 1. So in the second course the underlap is same 1 to 1 it reaches to this position and it remains in the same position, so this is so underlap is basically 0. So 1 and then 1 to 0 overlap then after this position it remains in the same position, so 0 to 0 this is underlap, so this is course number 1, this is course number 2.

So the beauty here is, if you carefully see 0 to 1 if you put down the sequence 0 to 1 after that 1 to 1 then 1 to 0 and then double slash, so this is just the 4 digit number. So what is the difference here, so 0 to 1 is the overlap which is 1 needle 1 to 1 underlap. So basically the guide bar remain in stationary, so it is just focusing on the same needle, so there is no switching and then after that 1 to 0 then again 0 to 0.

So how this is different than this one, so if you carefully see, so here the nature of loops become different. So if you see the lapping diagram, so this one the lapping diagram is 1-0, 0-1, 1-0, here 0-1, 1-1, 1-0. So here 1 to 0 is overlap, so overlap is 1 pitch, underlap is also 1 pitch 0 to 1 but here overlap is 1 pitch but 1 to 1 underlap is nothing, so underlap is 0 position. So with this you can guess like why this shogging motion is so important.

Because you can change the shogging motion amount, so far we have done 4 examples. So here the shogging motion was 0 to 1 which is 1 pitch and the underlap, here the underlap was 2 pitch 0 to 2, here the underlap is 0 pitch. So the underlap keep on changing but if you see overlap is always the difference is ,1 so 0 to 1 if you see another here also **0** 1 to 0. So difference is 1, so overlap is always for 1 needle.

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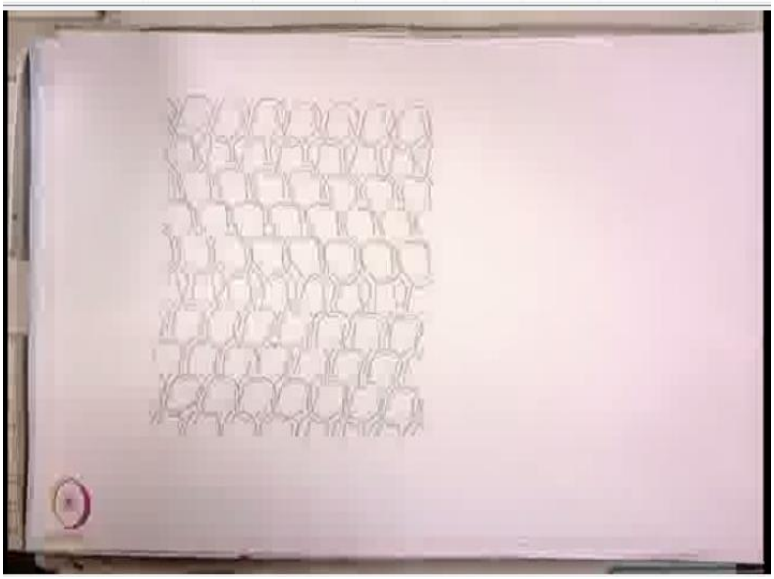

And underlap can vary from 0 pitch, 2 pitch, 3 pitch, 4 pitch, sometimes the structures can be very very complicated. So probably in the next class when I will describe some of the complicated structures where the lapping diagrams can be very very complicated.

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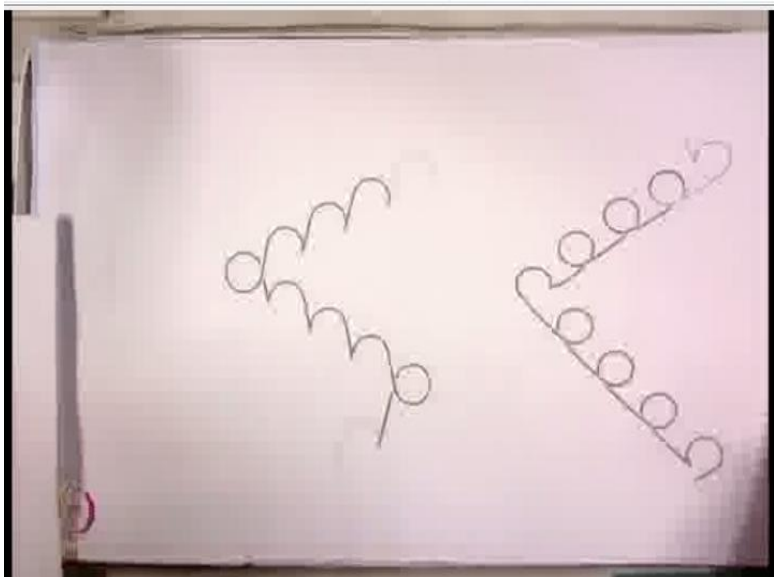

So the repeat unit can go for 8 courses whatever structure we have seen so far was like up to 2 courses repeat. But sometimes the repeat unit of each guide can go up to 5 courses, 6 courses, 10 courses and then the structures will become more and more complicated. So this I am going to explain in the next class.

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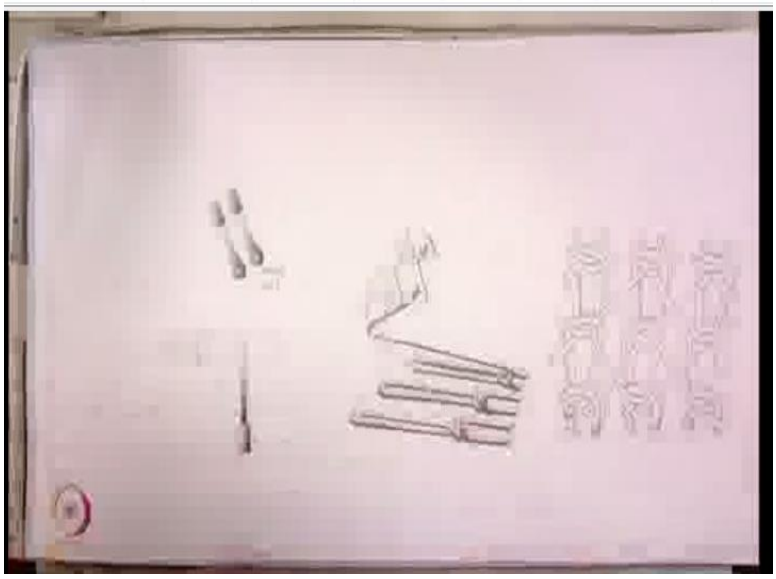

Once you understand the lapping diagram for one guide bar, the same thing can be extended for 2 guide bars. So when you have 2 guide bars you need to explain the lapping diagram of first guide bar as well as second guide bar. So individually you can draw the diagram and get the value.

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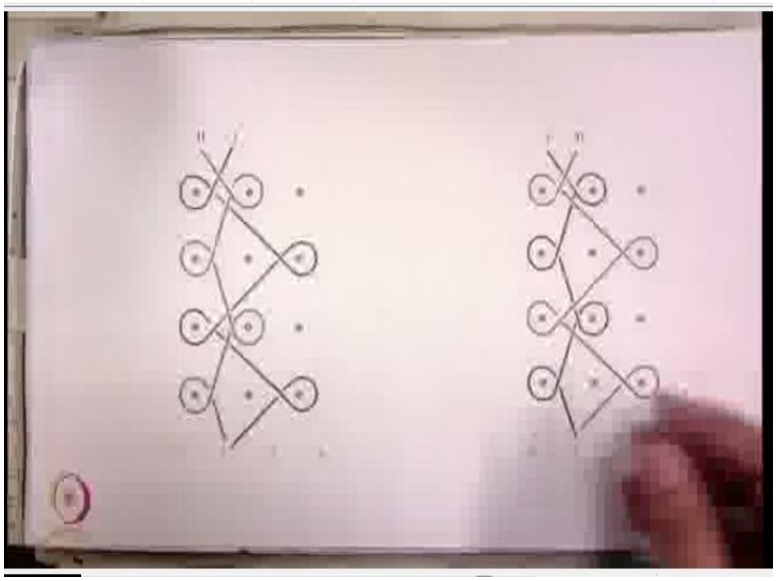

For example if this is a 2 bar structure, second guide bar is switching from first needle to second needle and if you see the first guide bar it is switching from third needle to first needle ok. So you can just write down this lapping diagram here, so here you can see this is the lapping plan, so for each guide bar you can write down this lapping plan. So for guide number 1 and guide number 2, similarly here also there are 2 different guide bars.

So 1 is switching from first needle, second needle, guide number 1, guide number 2 it is switching from first to third, first to third**.** So this is somewhere like this, so in this way the structures are defined more complicated structures can come.

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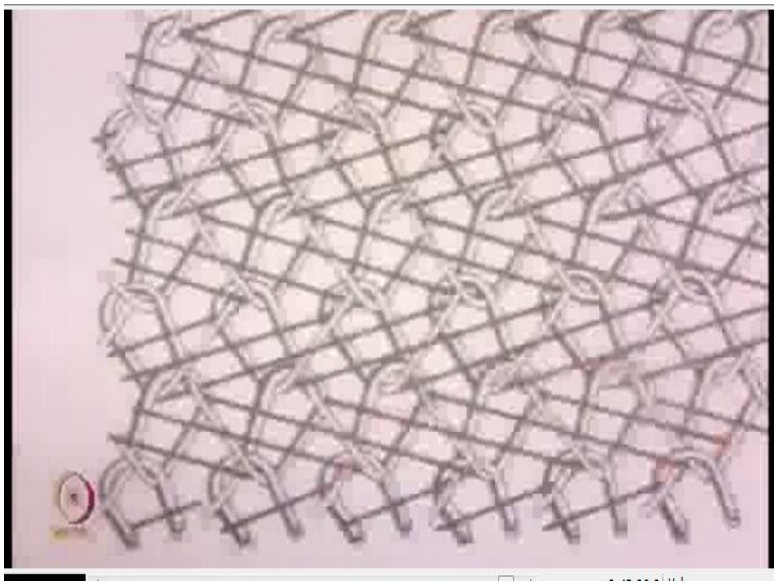

So if you see here one yarn is switching from one column to other column and the black one is switching from one column to fourth column. You need to collect all the informations in one place and then you need to design the lapping diagram for each guides. And in this way you can represent this fabric structure, more practice we will do in the next class so at this moment I think this is more than sufficient.

So I expect you to follow the assignments and do some practice on writing the lapping plan and also drawing the lapping diagram. So with this I am ending this particular lecture, so warp knitting is has to be carefully analyzed and this fabric notation is very very useful and handy when you are designing the fabrics. So with this I am ending this lecture see you in the next week, thank you very much.