**New Spinning Technologies**
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**Lecture - 27**
**Self Twist Spinning**

Today we are going to discuss Self Twist Spinning. So, the name itself implies that here is a spinning system where the yarns get self twisted.

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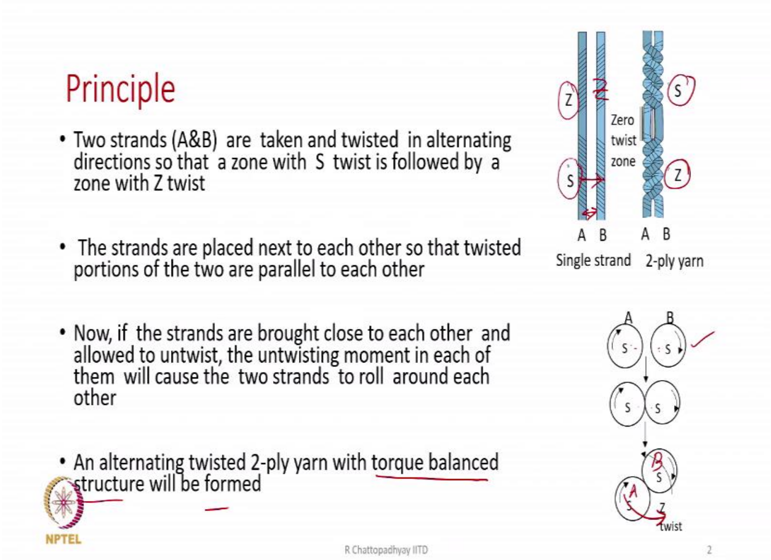


So, how it is going to happen that is what we will be discussing now. Now on the right hand side we are showing a diagram. First there are suppose there are two strand 'A' and 'B' ok and then in these two strands we are imparting twist in both 'S' and 'Z' directions that is part of the yarn is having 'S' twist and then it is getting 'Z' twisted.

Similarly, the strand 'B' is also is getting 'S' twisted in some portions followed by 'Z' twisted portions. So, both the yarns 'A' and 'B' having twist in alternative directions 'S' 'Z' 'S' 'Z' like that. So, some segments having 'S' followed by 'Z' then again 'S' then followed by 'Z' and same thing is happening to the other strand also that neighbouring strand which is 'B' in this case.

Now, if the two strands are placed next to each other and we remove this distance between them. That is they are brought closer to each other and then they are allowed to untwist because each individual strand has twist. So, there will be always untwisting torque. Fibres will always try to come back to their original you know undeformed state that is the actual tendency.

Now, if we bring this two strand close to each other and create a situation so that they can untwist. In that case what is going to happen? The untwisting moment in each of them will cause the two strand to roll over each other. Like here is the cross sectional view two strand ‘A’ and ‘B’, suppose that these two neighbouring portions are having ‘S’ twist and now we bring them close to each other and allow them to untwist.

If we do so, that is if the restraint is removed and we allow them to untwist then the strand ‘B’ and strand ‘A’ will try to roll on each other. And therefore, they will be twisted together in the opposite directions. So, ‘S’ twisted part will be twisted together and they will show the presence of ‘Z’ twist. So, the ply twist is going to be in ‘Z’ directions.

And we will get a torque balanced structure. So, wherever we have ‘S’ twisted portions the ply twist will be in ‘Z’ direction and wherever we have ‘Z’ twisted portions the ply twist will have in ‘S’ directions. And now, the individual strand twist and the ply twist they will balance each other that is the torque will balance each other and as a result we will get a two strand plied yarn and it will be torque balance.

There will be no untwisting torque in the plied structure. So, this is the principle. Now with this there is only one disadvantage. What is that?

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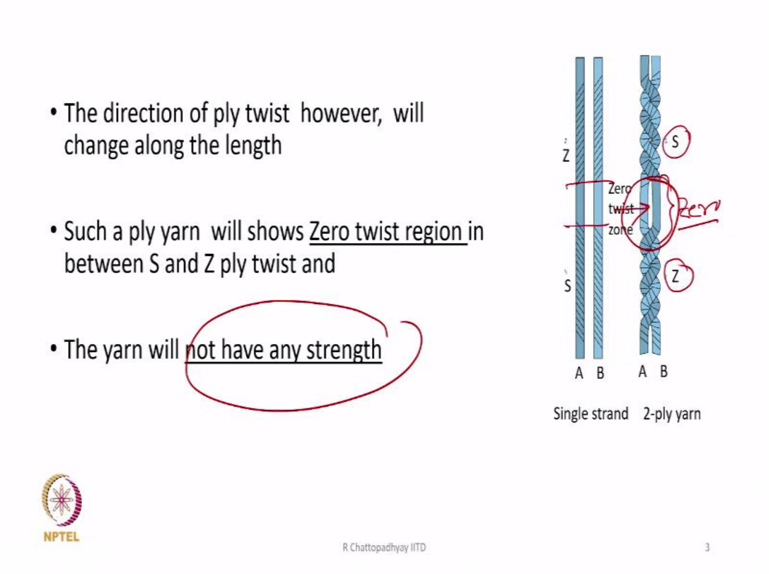


The direction of ply twist obviously will change. The ply twist direction is going to change that is there will be ‘Z’ ply twist followed by ‘S’ ply twist, but in between them there will be a portion where there will be zero twist. So, this zero twist portions of the individual strands ‘A’ and ‘B’ will also show zero twist zone in the ply twisted structure.

Therefore, where do we have ‘Z’ ply twist and where ever we have a ‘S’ ply twist there is no problem, but if both of them have zero twist as it is shown here this is the region where we have zero twist then this yarn as a whole will not have any strength. If we pull the yarn it will break in this zone.

So, even though there is a ply twist in ‘Z’ and ‘S’ directions along the length of the plied yarn still there will be places left where both the strand will not have any twist and therefore, that is the weak place and the yarn is going to break there whenever we apply tension. So, that is the you know the it will not have any strength if we you know ply the two strand in this particular manner.

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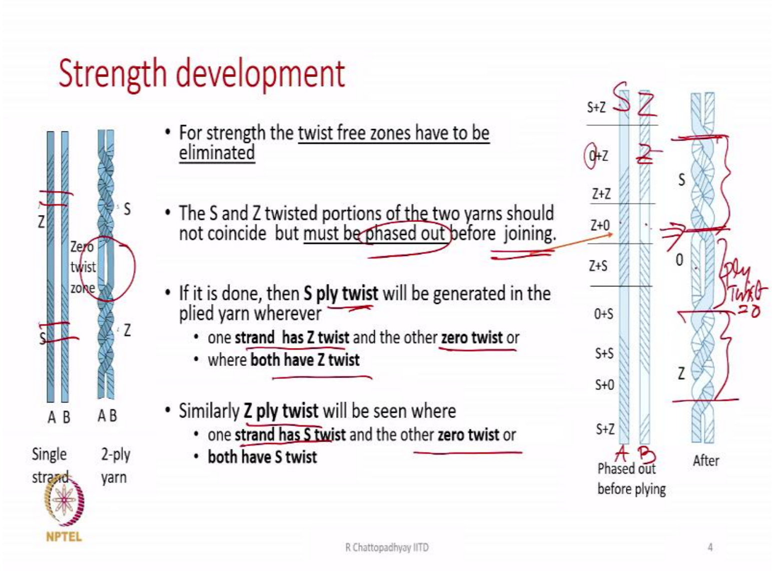


So, we have to think how we can develop strength in this kind of structure. For that for this strength to be developed we have to eliminate the twist free zones that is we have to get rid of this kind of zone where both the individual strand is not having any twist at all, this has to be eliminated.

And hence the ‘S’ and ‘Z’ twisted portions of the two yarns should not coincide and must be phased out before joining. That is the solution that we have that we must make sure that when the ‘Z’ and ‘Z’, ‘S’ and ‘S’ should not coincide before they really get twisted around each other, this has to avoided.

So, to avoid this kind of situation we have to go for phasing out. Phasing out means that one yarn has to be shifted relative to the other so that ‘ZZ’ portions ‘SS’ portion do not come next to each other. Now, if you see the right hand side diagram that is what has been done. There is a phase shift between the two strand ‘A’ and ‘B’ and if we look at this that is here is a portion where the strand ‘A’ is having ‘S’ twist and strand ‘B’ is having ‘Z’ twist.

Then there is a portion where there is no twist in this strand it is ‘0’ and the neighbouring part of the other strand is having ‘Z’ twist. So, it is ‘0+Z’. Then there is a portion where both are having ‘Z’ direction twist. Again, there is a portion where ‘A’ strand is having ‘Z’ twist, but the ‘B’ is having no twist.

This if we can achieve this that is before we allow them to roll over each other if we can shift the two yarns, we call it phase shift and then allow them to untwist and roll over each other in order to get you know in order to generate ply twist. Then what we will find that ply twist will be there wherever one strand is having ‘Z’ twist and the other is having zero twist or wherever both of them have ‘Z’ twist.

And if we see from here, we are going to this diagram and if you look at this portion where we have ‘S’ twist from here to there and from here to there we have ‘Z’ twist. So, the ‘Z’ twisted portion and ‘S’ twisted these are ply twist we are talking about. So, individual strand twist and ply twist they are different.

So, ply twist direction ‘S’ from that extend from here to here. Here the ‘S’ ply will occur if both of them have ‘Z’ twist or one of them have ‘Z’ and the other one ‘0’. Similarly, we will get ‘Z’ ply twist when one strand is having ‘S’ and the neighbouring one will be having ‘0’ twist or both of them has ‘S’ twist. And by doing so, what we are achieving? You look at the portions where there is no ply twist.

So, this is the portion where ply twist is ‘0’. It is shown here also, but in the zero twisted zero ply twisted portion the individual strand are twisted. So, even though the ply twist is ‘0’ here because the individual strand is having some twist here, so, this is not going to be a weak place and the yarn will be able to sustain some load, it will have some strength. So, this is the principle that we have to follow in order to produce such type of yarns.

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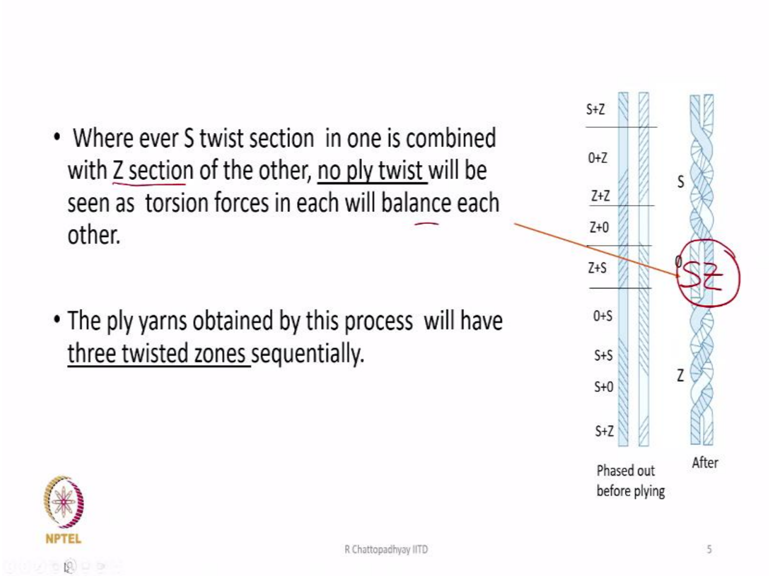


So, where ever 'S' twist section in one is combined with the 'Z' twist sections of the other, no ply twist will be seen there as torsion forces in each will balance each other. So, here is a portions where this part is having 'S' twist, but the neighbouring part is having 'Z' twist and because they are next to each other.

This torque is going to balance each other and therefore, they will not be able to roll on each other. And hence the ply twist is '0' here. The ply yarns obtained by this process will have therefore three twisted zones.

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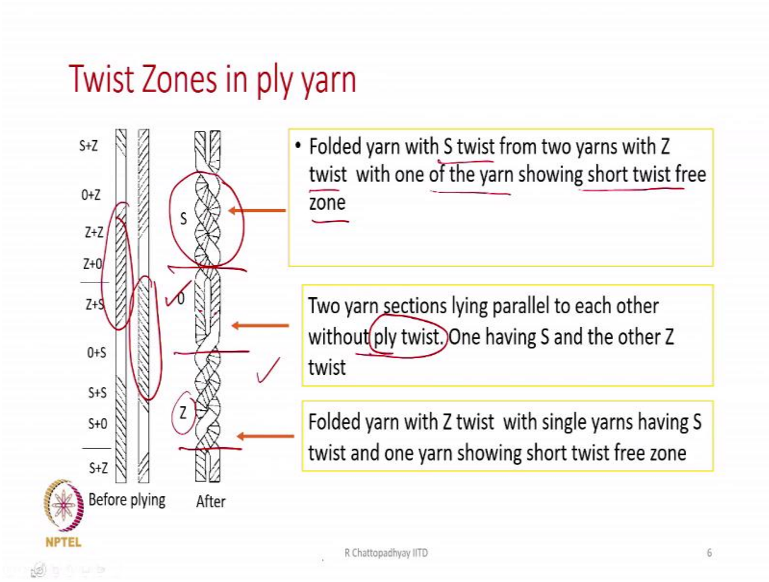

And they are shown now. If we study the plied structure, we will find three different twisted zones. The first zone is this one, where folded yarn with ‘S’ twist from two yarns with ‘Z’ twist with one of the end yarn showing short twist free zones something like this we will get.

The folded ‘S’ twisted direction is ‘S’, but individual yarn twist could be ‘Z’ ‘Z’ or ‘Z’ ‘0’ any combination is possible. And a portion like this where two yarn sections lying parallel to each other without any ply twist, there is no ply twist here, it is ‘0’ and there are portions where there are segments where there will be ‘Z’ ply twist. So, that is how the plied yarn will look like. See you have ‘Z’, ‘0’, ‘S’, again ‘Z’, ‘0’, ‘S’, ‘Z’, ‘0’, ‘S’ that is how the twist directions will be seen in the plied yarn of the ‘Z’ twist ply yarn.

Student: Sir, so, we need to see visually like both strengths are not are being same twist now. Or visually we have to see like both strands do not have same twist at same location?

Not visually, this is what we have to achieve and now the point is that if we can assemble these two yarns in this way that is by phase shifting the two yarns, we allow ‘Z’ and ‘Z’ ‘Z’ portions or ‘S’ ‘S’ portion not to be you know not to be adjacent to each other. If we do so, then there will be portions where the yarn will have only you know the ply twist portions. Where ever ply twist portions are ‘0’, the individual strand twist also be ‘0’ there and therefore, the yarn will not have any strength.

So, we have to create a situation so that that two neighbouring portions of the yarns which will going to join they should not have twist in the same directions. And if we want to do that now point is this is what is theoretically, we think that we should do it, we must do it.

Now, come the machine. How the machine is achieving this? What mechanism if they are in the machine so that first of all we have to twist the two individual strand by some means in order to generate ‘S’ and ‘Z’, ‘S’ and ‘Z’ twist in the individual strands?

Then we have to bring this two individual strand to a converging point and allow them to untwist. While we are trying them to you know we make them to untwist they actually roll over each other and they get actually ply twisted and it produces a torque balance structure. So, first point is that we have to have a mechanism to generate twist in alternate directions along the length of the yarn single yarns.

Now, bring two such yarns close to each other at the convergence point. While we bring them at the convergence point, we have to make sure that ‘Z’ ‘Z’ portion ‘S’ ‘S’ portion should not come together. So, that is this is what is required to be done. So, what has to be done is actually discussed till now. Now point is how we should we will going to achieve it. That is what the machine is going to do.

So, we will discuss now, how this is being done? First of all, what has to be done? and why it has to be done? and the next question is how we can do it? So, these are the three you know important questions that should come to the mind always that what we should do? why we should do? and how we should do?

So, what has to be done is this that is there has to be a phase shift. Why we should do it because phase shifting is going to give us a yarn which will be strong. Now, point is how; how will is we are going to achieve it. For that we need to discuss about the real technology.

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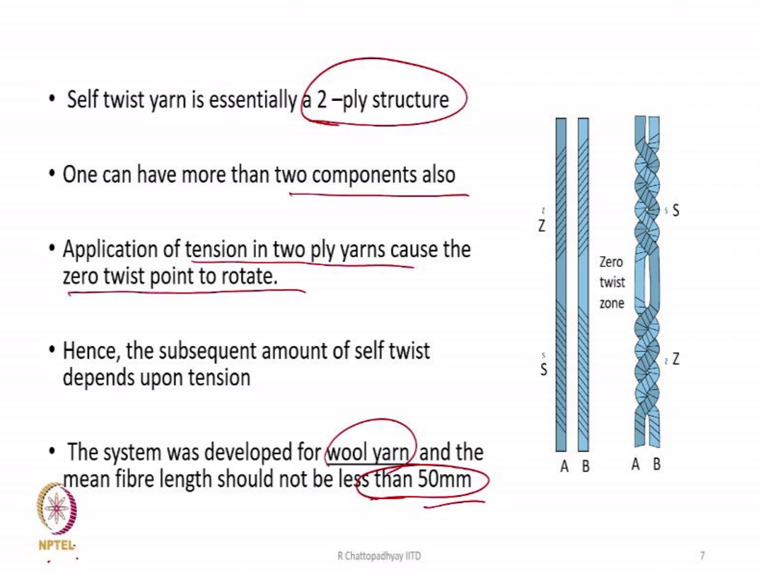


We can just say now that self twist yarn essentially is a 2-ply structure. One can have more than two components also. Application of tension in the two ply yarn cause the zero twisted point to rotate and there is a chance of twist redistribution depending upon the tension. The system was developed originally for actually wool yarns and is meant for long fibres. So, if you use long stable fibres that could be man-made fibres the system also can work with those manmade fibres.

And we need a length, the mean length of the fibres should be at least 50 mm. So, longer the fibre length better it is. So, basically it is a system meant for long stable fibres and wool belongs to long stable fibres.

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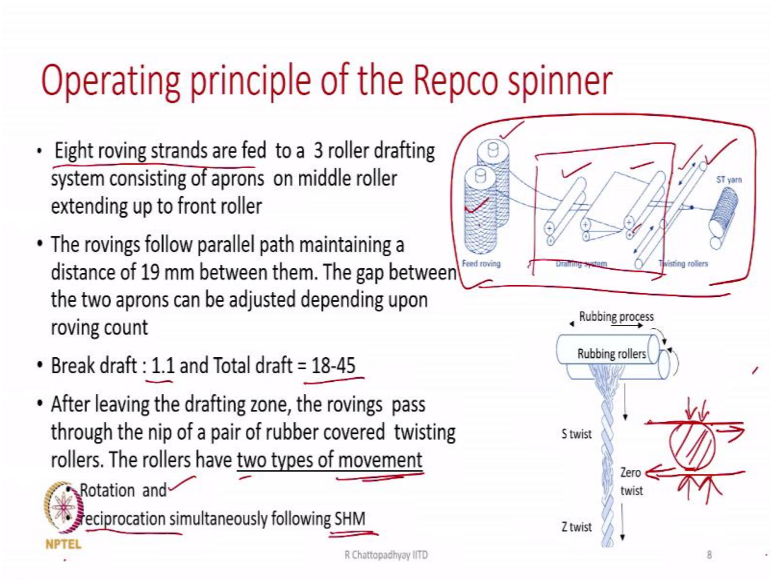


Now, we are going to discuss about the machine. Now, on the right hand side what we see? A schematic of the machine. Actual machine is not really, no, I am not going to show that it is only a schematic. So, we start with two feed rovings. In the machine generally eight rovings are fed. So, there are four production positions. It is a small machine. Four rovings, eight rovings are fed and there are four production positions.

See let us discuss about only two rovings to start with. So, rovings are fed and then we have a drafting unit which is from here to there, roller drafting units with aprons because we have to draft and the draft is break draft and total draft is this. So, we can find out what is the draft in the what is draft in the front zone also.

So, depending upon the count and the count of the roving and count of the yarn that you want to produce we can set the draft accordingly. After leaving the drafting zone we have what we have is 2 twisting rollers. These are the twisting rollers. This is the most important part of the machine. The twisting rollers are the really heart of the machine is the twisting rollers.

The twisting rollers have they have two types of movement two types of movement. One is they are rotating on their own axis the way other rollers also rotate. At the same time there is a reciprocating motion shown by these arrows. So, it is a rotation and also reciprocation and reciprocation motion is generally follows a simple harmonic motions. So, they are continually oscillating and the roving is in the nip of these two rollers. The roving is gripped by the two rollers.

So, the roving is experiencing a forward motion because the rollers are rotating on their own axis and trying to pull the yarn, pull the roving and at the same time delivering it also, but the reciprocation or reciprocating motion that we have this motion is going to impart twist because of friction.

So, we have basically a roving let us say like this and here is the surface and here is a surface of the rollers and that is some amount of pressure between the rollers and the roller surface is moving like this and therefore, it is getting rolled. So, the roving is getting twisted.

So, when it is the roller is moving in one direction, it is getting twisted in one directions maybe suppose that is clockwise directions and generating ‘S’ twist or ‘Z’ twist whatever it is and when it oscillates on the other directions then it will generate reverse twist.

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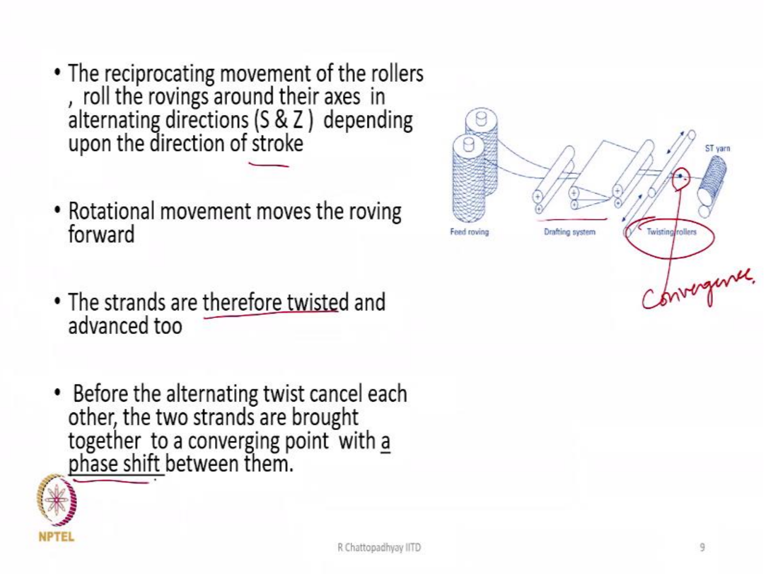


Therefore, the reciprocating movement of the rollers will roll the roving around their axes in alternating directions depending upon the direction of the stroke. And the rotational movement as I said will move the roving forward. Therefore, these two strands which are passing through the drafting zone and they are passing in between the two twisting rollers because these are the rollers which are actually ultimately generating twist.

So, they will be twisted, but the twist direction will keep on changing depending upon the direction of the stroke. Now as they move forward both the rovings and they are met to join at a point. This is this point, where this is the convergence of the two roving. After twisting, now they are coming out from the nip of these two rollers and reaching a point that is called the convergence point. Now when they reach there, we have to create a differences in the path length.

If the path length remains same, then there were no phase shift. So, there has to be a way to ensure that the distance from the nip to the convergence point are not same for the two rovings. One of them has to be larger than the other and that is what is called phase shift.

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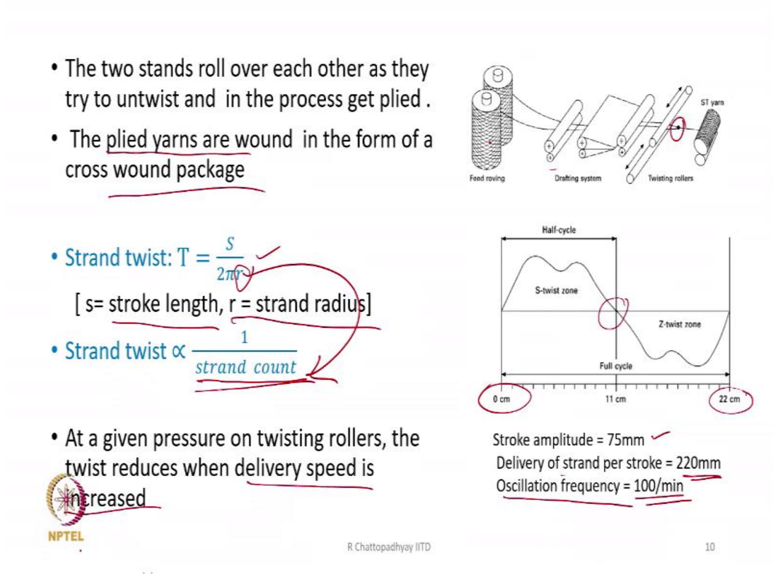


So, once they reach that point, I will come to little details about the phase shift. This two strand will be allowed to untwist and they will get they roll on each other now. And therefore, they will get plied and the strand twist is all we can write is '$S/2\pi r$', where '$S$' is the stroke length and '$r$' is the strand radius, which is a function of the you know the count of the roving and how much draft we are we are giving; so, how much stretch is there in the drafting zone and what is the linear density of the roving that we are feeding.

So, strand twist is basically inversely proportional to count. Because '$r$' is '$r$' depends upon the linear density of the individual strand that is the count of the individual strand and therefore, strand twist; that means, if I want to if we go for final roving strand twist will be more. If we everything remaining same if we go for coarser roving or coarser strand this strand twist will be less because it is basically a function of the diameter.

For a given stroke length the only variable is the '$r$' and '$r$' is proportional to the linear density of the drafted roving. If this is the roving then after drafting what is the linear density of this roving or for a fixed draft it will be directly dependent on the roving count. The other interesting part is at a given pressure of the twisting roller the twist reduces when the delivery speed is increased.

Obviously, now ultimately how many times the roving is rotated you can say or roving is turned by the stroke of the oscillating rollers and during that time how much I am delivering. This ratio is basically the twist per unit length. So, how many times the roving is going to rotate on its own axis when in one full stroke? If it rotates by ‘*n*’ and in that time how much I deliver. If that is whatever it is ‘*x*’, then ‘*n/x*’ is going to be the twist in the final strand.

So, in a given stroke how many rotations happens to the roving and how much we deliver and we take the ratio of these two that will give you the twist in the roving. That means, in one cycle how much how many turns are generated and how much is delivered. Typically, the way the twist varies is shown here. Generally, the stroke length is typically 22 cm.

So, ‘S’ twist followed by ‘Z’ twist and there is a zone which is zero twist. It is not really a point, but actually it will be the actual case it will be a kind of zone. So, ‘S’ twist will be gradually developed and then it will go down and ‘Z’ twist it will be there. So, the along the length of the individual strand you will have ‘Z’ ‘S’ ‘Z’ ‘S’. And between ‘Z’ and ‘S’ there is a portion which will be close to ‘0’. So, stroke amplitude is 75 mm, delivery of the strand per stroke is 220 mm, oscillation frequency is generally 100/min.

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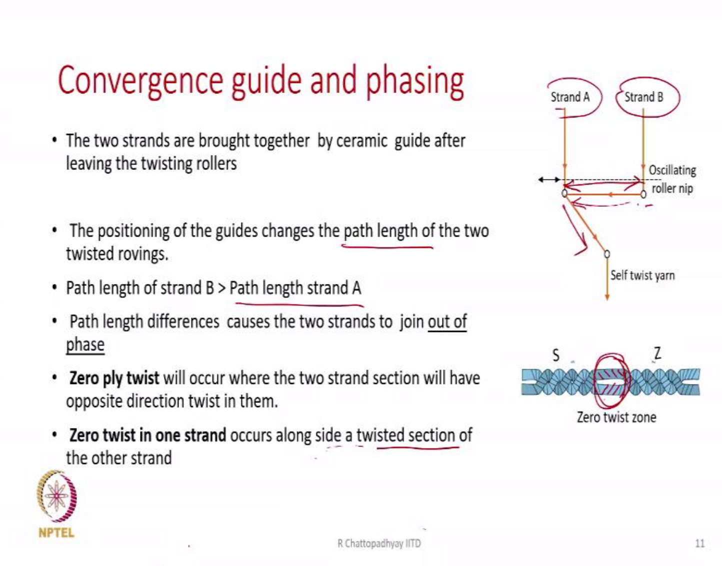


Now, how the phasing is done? As I have mentioned that after the rovings lift, the nip of the twisting rollers and before they join the convergence point. The path length for the two strands ‘A’ and ‘B’ has to be different. So, if suppose this is the strand ‘A’ and this is strand ‘B’, the strand ‘A’ is moving. The path length is shown here by this arrow and strand ‘B’ is also shown.

So, strand ‘B’ takes a turn. There is a guide over here, it takes a turn and then moves like this. So, this is the additional path from here to there. This is the additional path that strand ‘B’ has to travel and because of this there will be phase shift. So, positions of the guides will actually change the path length.

So, path length of ‘B’ in this case is greater than path length of strand ‘A’. So, we can change this and change the phase. Zero ply twist will occur where these two strand sections will have opposite direction of twist in them. We have already discussed that there is some portions. It is not shown here. It is appears to be almost you know ‘0’ twist in the individual strand. But in actual cases the it will have if this strand is having twist in ‘S’ directions the neighbouring part will have a twist in the ‘Z’ directions.

And therefore, here when they remain parallel, they will balance each other. See if I write like suppose I draw this properly then if I draw in this strand this way this would have twist will be like this. And ‘0’ twist in one strand occurs along this side looks along side a twisted section of the other strand. This we have already discussed. The same thing is going to happen. The moment we go for a phase shift whatever we have now we have you know discussed earlier everything will be valid.

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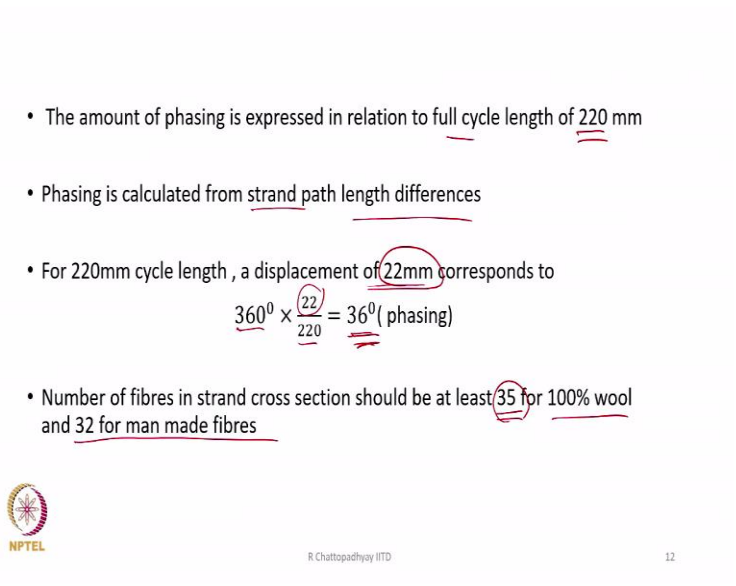


The amount of phasing is expressed in relation to the full cycle length, it is 220 mm. Phasing is calculated from the strand path length differences. For a 220 mm cycle length, the displacement of 222 mm will means, 36º phasing. One complete cycle length is equivalent to 360º.

And therefore, for 22 mm path length differences the phasing in terms of angle is going to be ((360/220)×22) which will give you a value 36º. For such kind of you know technology, the minimum number of fibres which is required is around 35 for wool or 32 for manmade fibres because manmade fibres are much more regular. Wool, there is a length differences. All the fibres in the wool may not be exactly of same length. So, typically this is the bare minimum number of fibres which is required.

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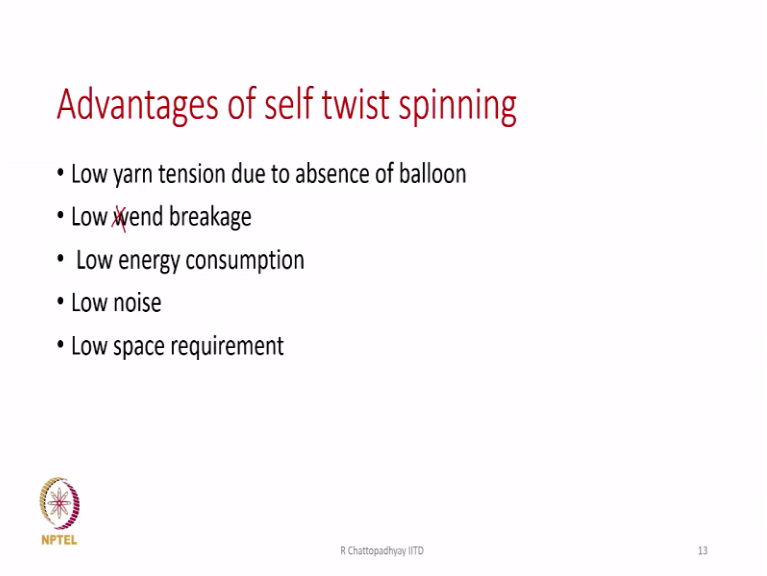


The advantages of self twist spinning is, low yarn tension due to absence of balloon, the absence of traveller. So, spinning tension is very very low. Low end breakage, the end breakage also will be low because tension is anyway very low. So, breakage possibility is very very less. Low energy consumptions because that balloon is not there, the big spindles are not there.

So, heavy rotating parts if we can reduce the energy consumptions will obviously reduce and that is no pneumatic, there is no pump or no suction, no blower. Therefore, we also know the energy consumption overall is much less and it also low noise. Most of the noise in the ring spinning is because of the rotation of the balloon. Low space requirement, So these are some of the advantages.

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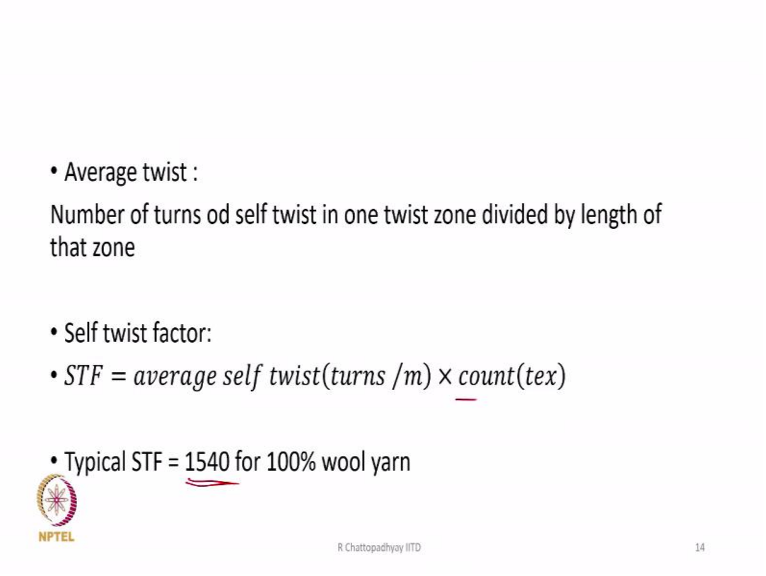


And the average twist number of terms of self twist in one twist zone divided by the length of that zone. So, this calculation we all know how to do it. So, and the self twist factor is 'average self twist (turns/m)×count (tex)'. So, this is basically a self twist factor which you will get. And typically, the twist factor for self twisted yarn is around 1540 for 100% wool yarn.

So, just a typical value is this given here so that we get some idea what kind of twist factor could be there in the case of wool yarns.

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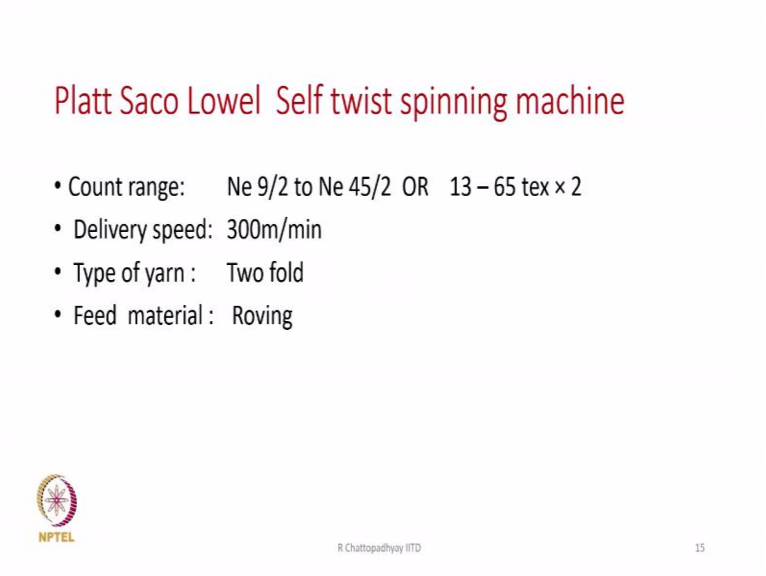

Platt Saco Lowell is the company that manufactures these machines and typically count that is spun is 13 to 65 tex 65 tex × 2; that means, it will be basically 130 tex. Delivery speed is quite high - 300 m/min. The yarn type is two-fold. Feed material is roving.

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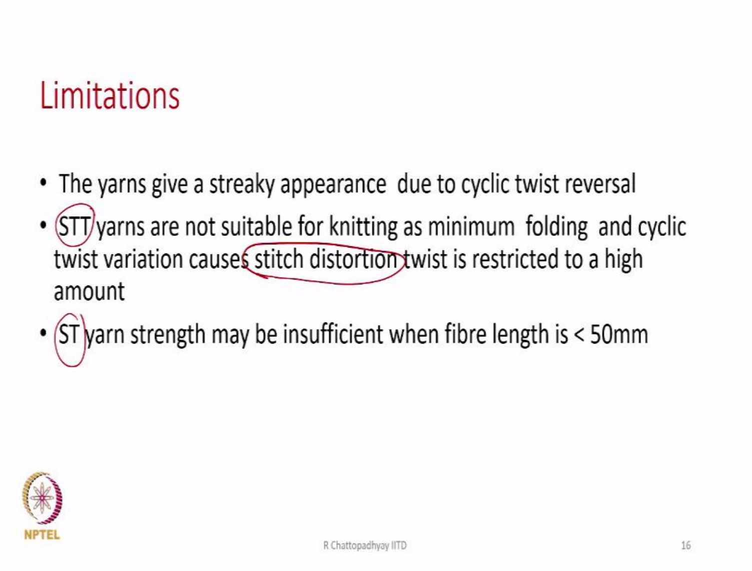


Limitations are the yarns give a streaky appearance due to cyclic twist reversal. One is individual strand twists are continuously reversing along the length of the individual strand. The ply twist is also is continuously changing along the length of the yarn. See you have ‘S’ ‘Z’ ‘S’ ‘Z’ ‘S’ ‘Z’ like that it will continue and hence the appearance of the fabric may be streaky.

STT yarns that self twisted yarns sometimes they are twisted again. The self twist yarn is taken and we again twist them, but they are these yarns are not suitable for knitting as minimum folding and cyclic twist variation causes twist distortion and twist is restricted to a very high amount.

So, that is the problem that is the twist the stitch distortion that is the loops will be very much distorted. So, they are not sure because most of the wool yarns also if you look at the applications knitted production made from wools. There are lot of knitted production made from wool like sweaters. So, this is could be one problem that could be stitch distortions.

And the ST yarn strength may be insufficient when fibre length is less than 50 mm. So, it is basically suitable for long stable fibres. So, ST yarn means self twist yarn and STT means self twist yarn we have again take it for further twisting then we call it STT yarn. So, there is too much of twist. So, yarn is going to be very twist slably also.

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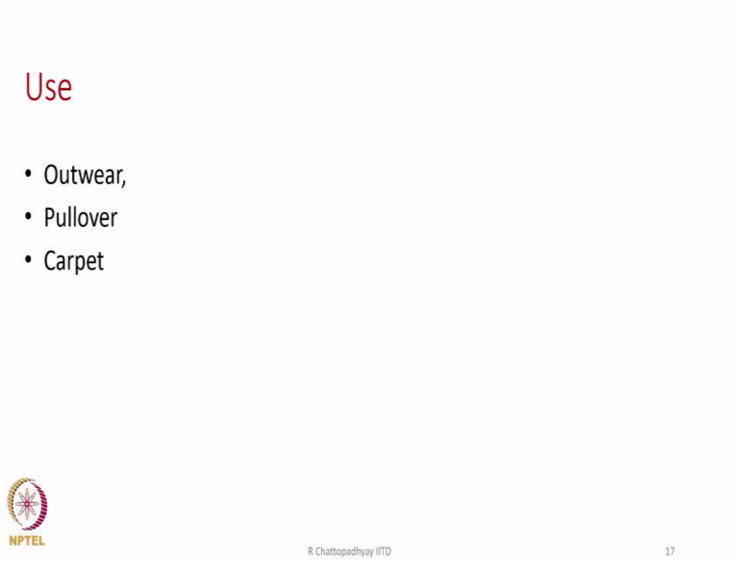


And use is pullover, carpets and any other outwear products that we make from wool or from wool synthetic fibre blends. This is what the these are the possibilities and with that we close this particular discussion on self twist spinning. So, self twist spinning ultimately gives us a plied yarn. We are not producing a single yarn that you have to you know you have to you know keep in mind that rest of the spinning technologies we are producing single yarn.

We can produce single yarn though there is possibility of producing plied yarn also in other technologies are there. But the option is there, but here there is no option to produce single yarn. We have to produce a plied yarn, ok. With this we close today's session and.

Thank you.