Evaluation of Textile Materials
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Lecture-33
Evaluation of Yarn Evenness (contd…)

Hello everyone, so we will continue with our present topic evenness ok, so what we are discussing that the various aspects of evenness, evenness in textile material mainly during spinning.

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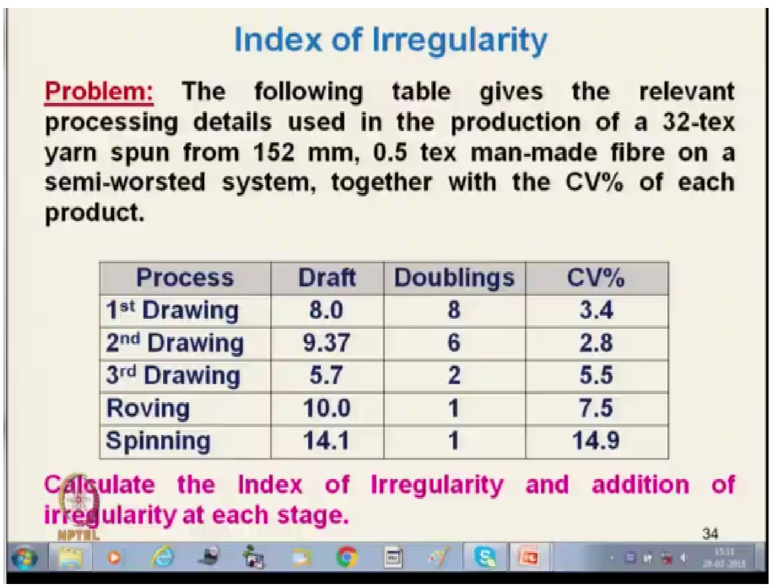

The materials are in the form of sliver that we get from the cording draw-frame and in the form of roving. So, this is the roving form and in the form of yarn ok, so here what we are discussing different aspects of evenness and how to express the evenness ok. And also in last class we discussed detailed about the limit irregularity that is the minimum irregularity possible for the given machining machine system and from a particular fibre.

And then we have discussed the index that is index of irregularity by which we can if we know the index of irregularity we can compare the performance of a particular machine. So, we have done different numerical and this we have we are discussing this numerical this is actually for process in semi-worsted system where a fibre of manmade of say polyester of 0.5 tex fibre from that 32 tex yarn that means span with this process systems with 3 drafting drawing system, first drawing, second drawing, third drawing and roving and the spinning.

In every stages what we have done, we have actually it is draft is being added, so as been discussed when we add draft, so it adds irregularity CV% increases. We have seen how to calculate the increased CV% if we know the output CV% and input CV%. So, we can now we can calculate the addition of CV% ok, so and also we have discussed that the reduction in CV% is by doubling.

So, here at different stages in this numerical it is showed that the draft at different stages are given first drawing there are 8 doubling, second drawing 6 doubling, third drawing 2 doubling and then roving and in ring-frame where is no doubling that is single strand has been stretched. So, and **c** CV% of different stages output product has been given like yarn CV% is 14.9%, roving 7.5, third drawing sliver 5.5, second drawing sliver 2.8 and first drawing sliver CV is 3.4.

So, with this data we have seen how to calculate the index of irregularity and addition of irregularity at each and every stages.

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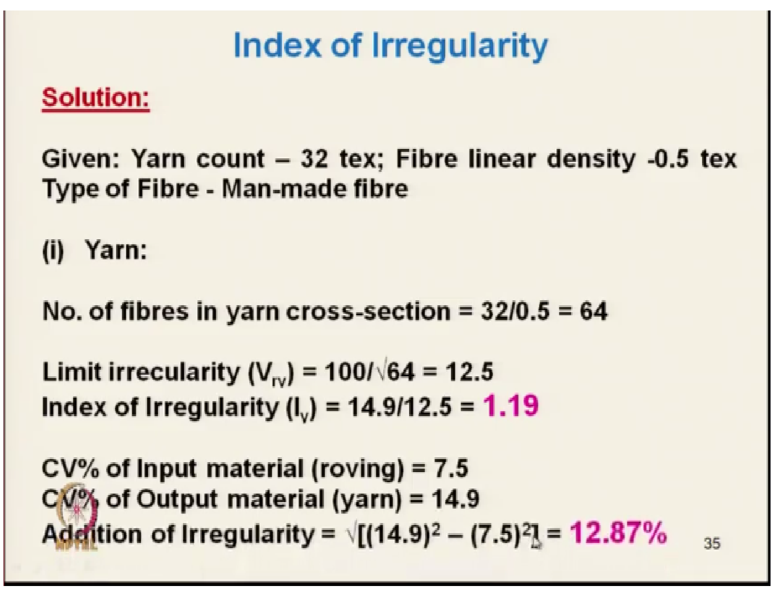

So, these are the different stages steps that we have seen, the yarn we know the count, linear density of fibre is known, type of fibre is manmade fibre. Then we can calculate the number of fibres in the cross-section of yarn 64, then limit irregularity using the standard formula 100/under root number of fibre that is the limit irregularity, we have calculated of yarn, index of irregularity we have calculated by comparing the output yarn CV.

And then we know the CV of input material here in ring-frame that is roving CV it is given the 7.5 is the roving CV and the output CV material that is yarn CV we know 14.9, then we can calculate the addition of irregularity. Similarly we have seen at different stages how the CV is being added, we can calculated, we have calculated at different stages what is the addition of CV and also index of irregularity we have calculated ok.

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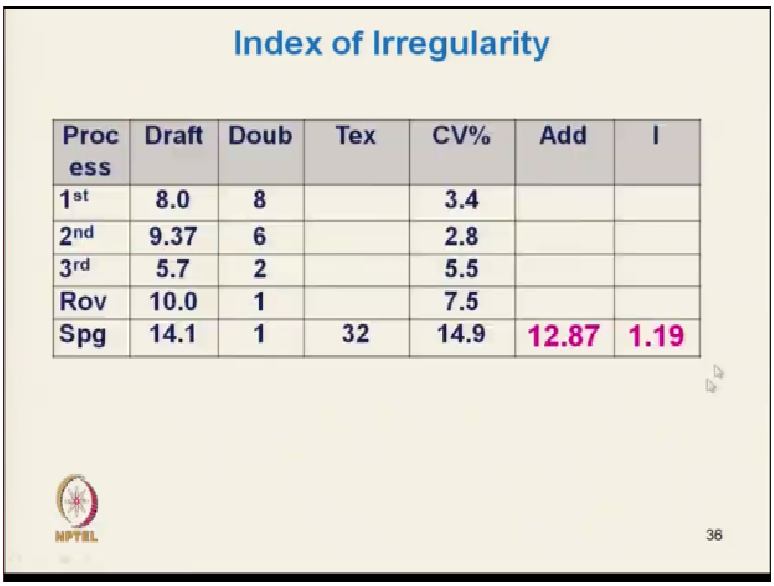

Process	Draft	Doub	Tex	CV%	Add	I
1st	8.0	8		3.4		
2nd	9.37	6		2.8		
3rd	5.7	2		5.5		
Rov	10.0	1		7.5		
Spg	14.1	1	32	14.9	12.87	1.19

Now it is 1.9 and 12.87 is the addition of CV% and 1.19 is the index of irregularity.

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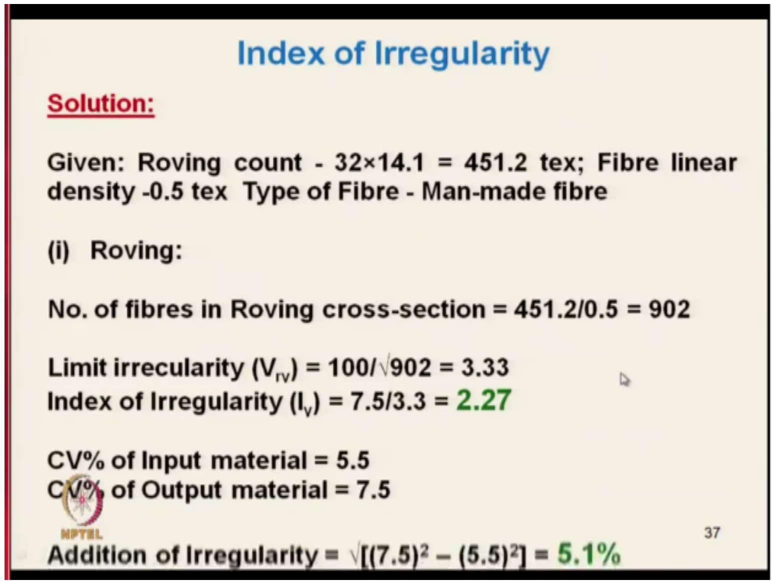

Similarly in roving we have seen exactly the similar fashion.

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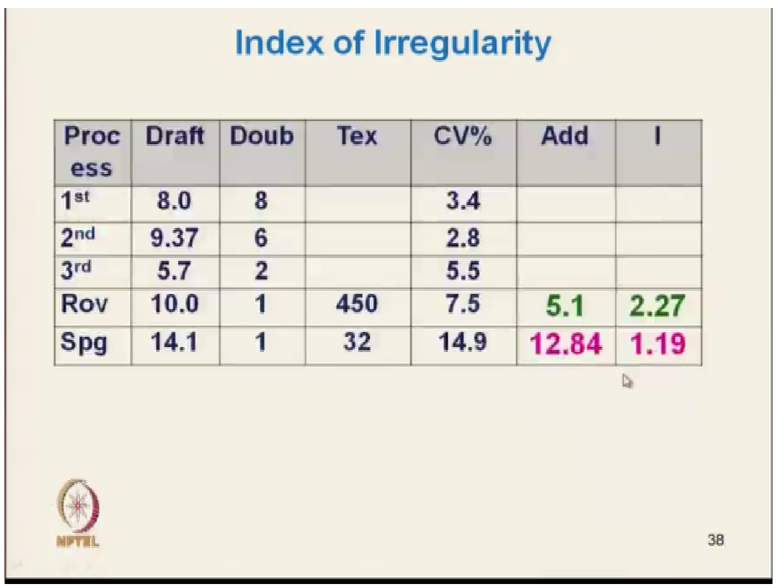

Process	Draft	Doub	Tex	CV%	Add	I
1st	8.0	8		3.4		
2nd	9.37	6		2.8		
3rd	5.7	2		5.5		
Rov	10.0	1	450	7.5	5.1	2.27
Spg	14.1	1	32	14.9	12.84	1.19

Index of irregularity is 2.27% and addition is 5.1%, so 5.1% addition, 2.27% is the index of irregularity of roving frame.

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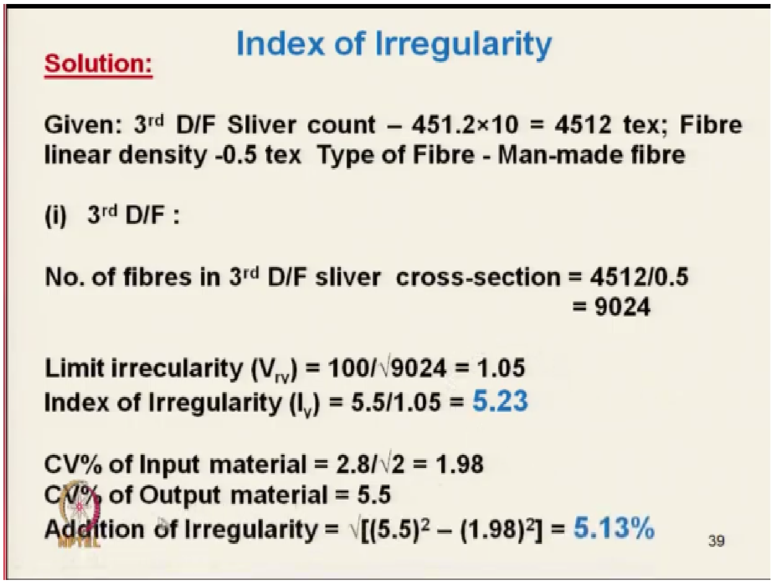

And similar way third draw-frame we have calculated we have seen the index of irregularity is 5.23 whereas addition of irregularity is 5.13.

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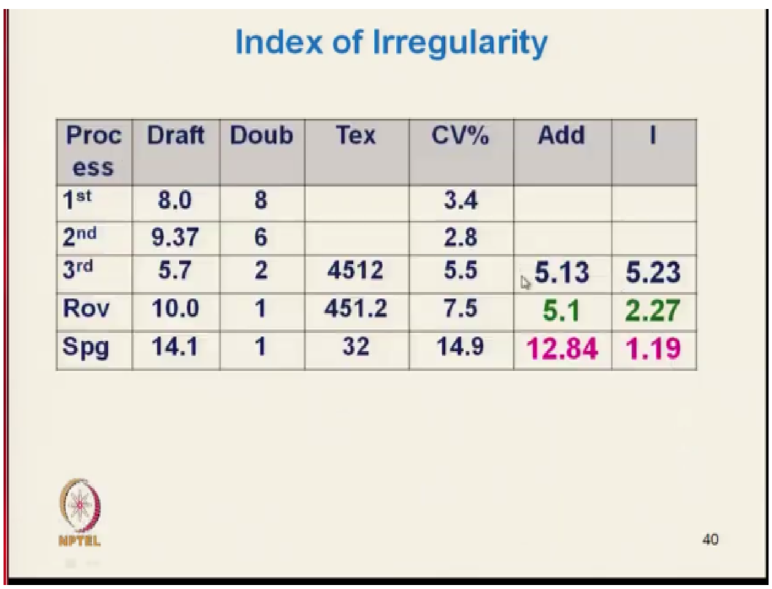

Process	Draft	Doub	Tex	CV%	Add	I
1st	8.0	8		3.4		
2nd	9.37	6		2.8		
3rd	5.7	2	4512	5.5	5.13	5.23
Rov	10.0	1	451.2	7.5	5.1	2.27
Spg	14.1	1	32	14.9	12.84	1.19

Now and then we have seen that one can calculate in the similar fashion in second and first drawing process. So, one you can try to calculate this and amount this data which we have already got third roving third drawing the roving and spinning that is ring-frame. If we compare, so addition of CV% in spinning although it is very high 12.84% and here it is a this is 5.1% and 5.13% but if we compare the index of irregularity, here it is a 1.19%, so that 1.19.

So, index of irregularity in the spinning process it is low, so that means the running performance of yarn, running performance of this ring-frame is better than the roving if we compare the index of irregularity. So, here it is 12.87% addition but index of irregularity is only 1.19%, so we can compare the by index of irregularity particularly normally we compare the for similar type of machine.

We normally do not compare from roving to ring-frame and so if we want to compare we compare between the yarn formation and typically from the further same similar type of product ok and similar type of raw material.

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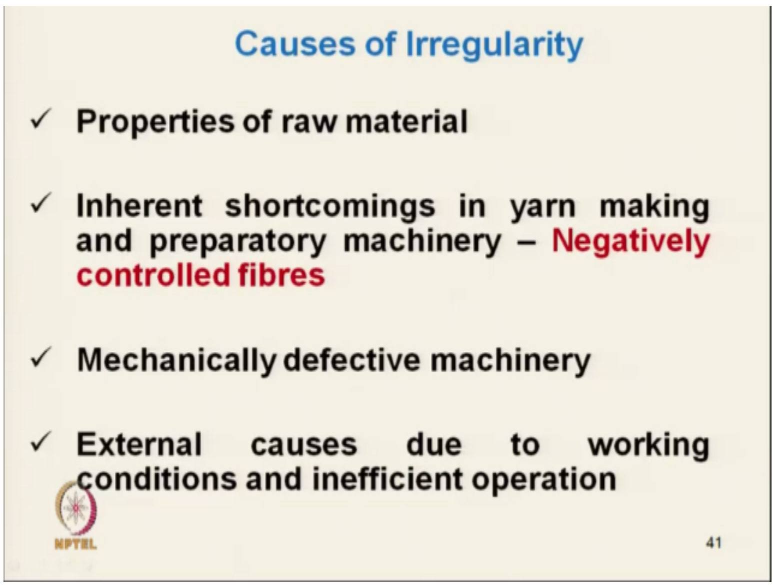

Now we will discuss our next topic it is a causes of irregularity, so irregularity is definitely has to be there. So, in any product, any material suppose this is a roving, in this roving this is a roving ok.

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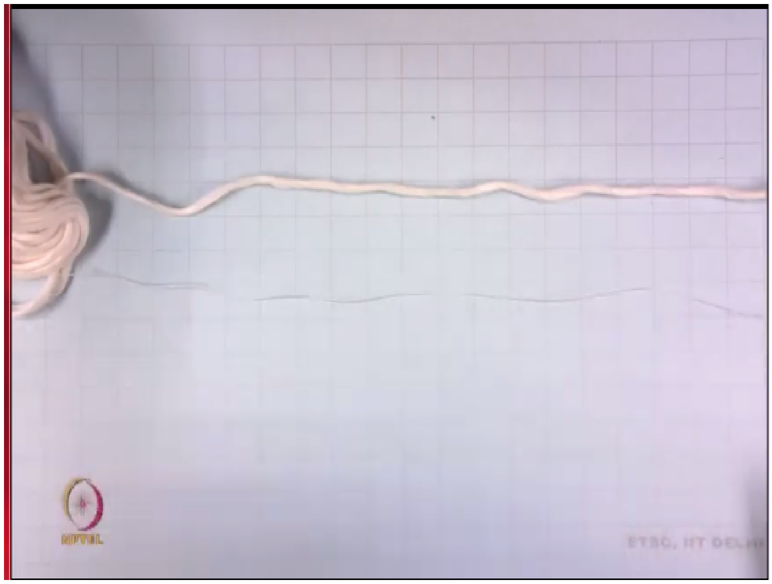

Here there will be irregularity even if you see the if we take the yarn, yarn has got large, in the actually variation in the diameter as well as mass/unit length. So, this variation are having for different results, first is that it is a properties of raw material. So, raw material we cannot have 100% even, even means even in terms of diameter, even in terms of length ok.

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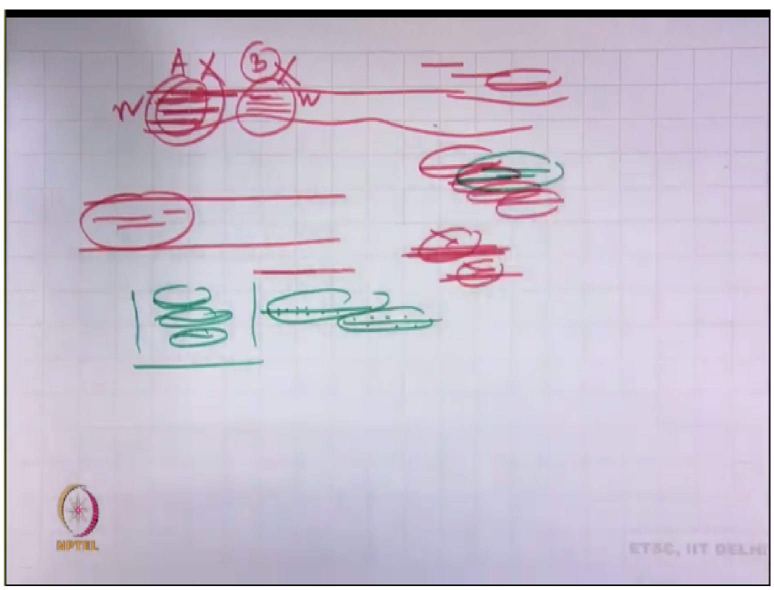

Suppose if we see the this is a yarn ok this yarn is made of a large number of short fibres ok. So, this fibres this suppose here the fibre linear density if we have even if we have placed same number of fibres at different places. Here at zone A and zone B by chance where in zone B the number of fibres if it they are same in but in zone A by some probability there are course fibres, in that case that is the fibre linear density variability it affected ok.

So, if we have fibre with the same linear density there is no variation like manmade fibre we will not have this type of problem ok. So, for natural fibre the variability is more because of the inherent variability in the raw material. Similarly for manmade fibre the length of fibres are exactly same we can maintain the length of fibres ok exactly same. So, due to the length variation the floating fibres and other due to other reasons.

So, this draft ability of the short fibres are poor and so that this will result unevenness in the material. So, due to the inherent nature of the raw material, nature of the fibre unevenness in the fibre it adds to the unevenness of the yarn, final product ok. And also the raw material like the fibre if we see the fictional characteristics of different fibre it is not uniform even for cotton, same cotton fibre.

We have different frictional characteristics due to presence of different actually that wax present, wax are it is cannot be same for all the fibres. Even for the synthetic fibre the spin pin switch is allow which is actually applied on the fibre this may not be same for all the fibre. This spin fin is this pin did the same for all the fibres, so that is why the fibre to fibre friction it is different for different value even within a same lot, within same lot different fibre will have different frictional coefficient.

So, that the due to the variation in friction their draft ability is different, so the fibre slides fast each other at different fashion within mass of fibre ok. So, that is why the inherent nature, inherent variability of raw material actually adds to the irregularity of the final product like yarn ok. Next is that inherent short coming of yarn making and preparatory machinery, so basically the spinning process, short staple spinning process or staple spinning process is not like other engineering material.

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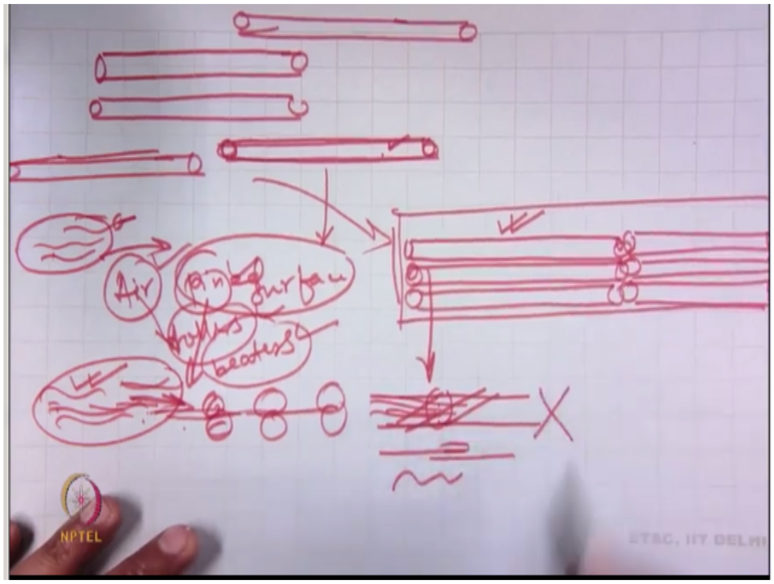

Suppose I will give 1 example, I have large number of rods ok, this large of I have rods or pipes I can say here the pipes ok. Now it is lying somewhere ok these are the pipes, now I have to arrange this pipes in a proper way. So, I have to arrange in a heap form, so what I will do by some mechanical means or manually I can arranged very easily because it is a larger in dimension and stiffer in nature, this is stiffer ok and this had got this I had this pipes or rods they have certain dimension ok larger.

So, I can put this, I can try to arrange this pipes in this way, so I am arranging in this fashion ok. Next pipe I can just put here like this, so I can arrange as per my wish, so I can arrange in this fashion okay, so this arrangement is totally controllable. And I will get a material of at least the shape of the heap will be a very uniform but the situation for fibres to be arranged in yarn is entirely different. Like fibres if we see the dimension wise fibres are extremely fine in terms of micron diameter and they are highly flexible and so and the quantity number of fibres are very low.

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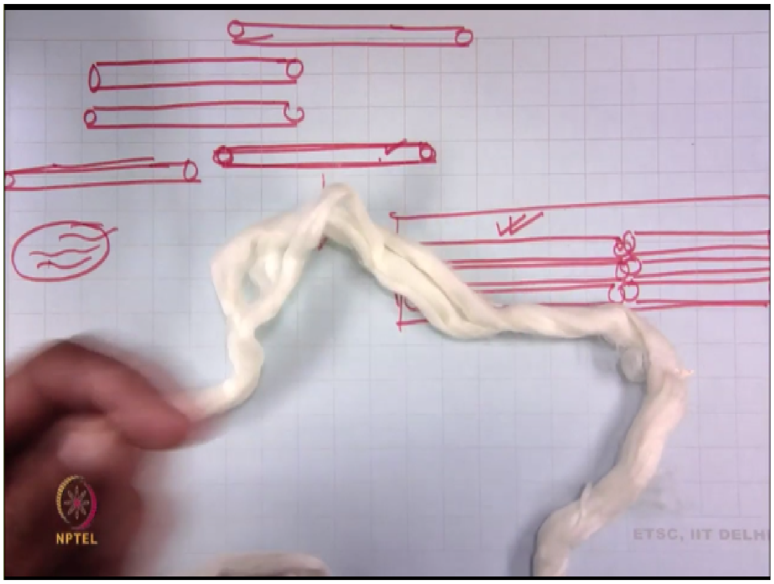

So, if we see this sliver here if we see there in the cross-section the fibres are large number of fibres and there dimension is very fine. So, it is controlling this fibre individually and placing in the sliver it is not possible that is why the spinning the short staple fibres spinning technology is evolved in indirect fashion, indirect control of fibres which means the fibres are not individual fibres are not being controlled not been actually arranged like this.

There either their travel, they are actually transported from 1 machine to another machine by air current or by pins or by rollers or by beaters or by ruler arrangement ok. So, this movement of fibre strength by all these negative flee controlled arrangement causes that random motion of fibre. Fibres are not being controlled like this type of rods they are not being controlled this fibres are actually with totally uncontrolled by a movement.

And the machines the designing of machines are actually just to improve just to control this movement as for as possible. So, our inherent nature of the production says that this fibres are not being controlled positively they are negatively controlled. So, negative control means the most of the fibres are majority of the fibres are negatively controlled they are placed on the yarn surface like this is.

This is the yarn they are placed on the yarn surface by some mechanism but not actually properly positively control, they are negatively control. So, this arrangement by drafting by the rulers or air movement by airs or pin surface, pinned surface like carding. In carding or maybe combing or, so in those cases we cannot ensure that all the fibres will be straight, all the fibres will be arranged in a perfect manner ok.

All number of fibres in the cross-section will be exactly same, so there would not be any hood formation ok there would not be any baffling there would not be any in non-alignment. So, all the fibres will be just parallel this all this things we cannot ensure, so our inherent nature of the production, inherent technology it is basically negatively controlled fibres. So, this actually result causes the irregularity in the fibre strength ok.

Third is that mechanical defect of machine, so even the technology says technology wise it is ok, so we can we do not have any other alternative. So, what we can do, we can at least improve our machinery keeping the technology same, so we can improve our machinery. So, even if in that case the defective machinery adds to the defect though irregularity like.

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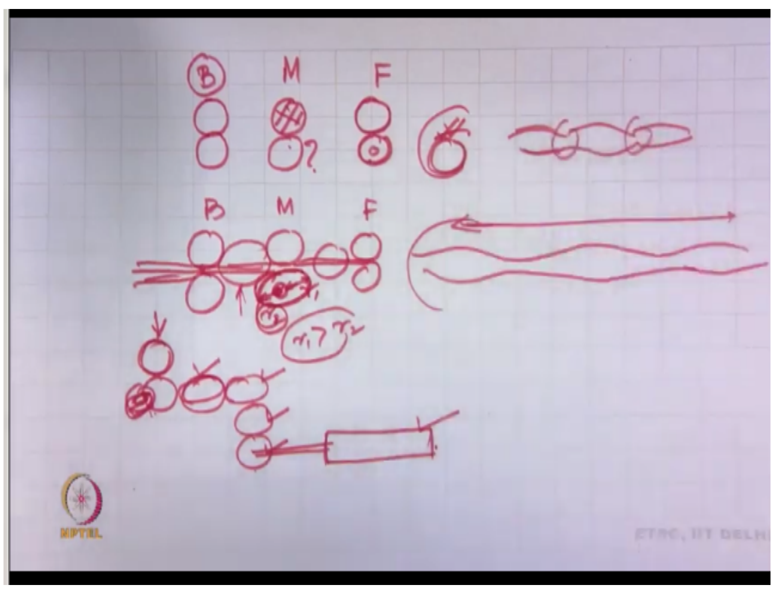

Suppose the roller drafting, the rollers are supposed to be perfectly circular, so suppose roller A this is the front roller, middle roller, back roller. Now suppose the middle roller this is not circular, this has got some defect and normally in rollers this roller has got defect. The defect basically roller in the roller defect is basic most common defect is the eccentrism, suppose this is the eccentric by some reason this has become eccentric and this is the roller, front roller.

Now front, middle and back, so this roller has become eccentric now what happen during drafting due to the eccentricity there will be thick and thin places generated. And there will be change in the meat point and also the motion of the speed of this bottom roller. Now once the speed changes because the radius here r1 and r2 they are different, r1 is more than r2, so when it comes r1 position and it is rotating.

So, that will have different draft than in r2, so that speed of r1 this bottom roller changes due to the eccentricity. So, when it is reaching r1 that means it will draft the material at higher rate ok then higher draft will be there, so that will create a thinner material. So, in this way the final product will have, so thick thin places, so this is causing 1 periodic fault, that I will just discuss ok, periodic fault ok, random fault that we will discuss.

So, this type of fault is induced due to the defective mechanical defect of the machine another type of defect may occur very common. Suppose these are the gears, pinions ok this are the pinions they are driving some rollers, drafting rollers say drafting ruler. Suppose this is a driver and here it is driven and with this 1 say either front roller, back roller or middle roller they are connected.

Suppose there is a defect in the teeth of this roller, this teeth is defective ok broken teeth, now what will happen here. If 1 tooth is broken ok then this for 1 rotation of this roller will have will give jerk motion to this roller and this jerky motion will get transmitted to this ultimately this roller. And that will give similar effect of periodicity when the particular roller this roller suppose **is** it is giving it is jerky motion.

This is giving this is bottom roller actually it is it is rotating continuously. But at 1 point it gives jerk sudden jerk, suddenly it is moving faster or slower, that will create 1 thick or thin places. So, after certain interval which is equal to this circumference, so that in that way so it will create another periodic fault, so if the machine, machine condition is poor.

So, that will normally that creates the periodic fault ok, so inherent defect of machinery that create fault also. Suppose the in carding, carding that way this tooths are broken, so it is not grinded properly. So, what will happen this will create that difficult that higher irregularity because the fibres fibre opening will not be proper, so irregularity of the material will increase.

So, another reason is that external reason that is due to improper working condition what does it mean improper working condition. Suppose in the spinning shade the humidity is not maintained properly, so what will happen in humidity is not maintained properly.

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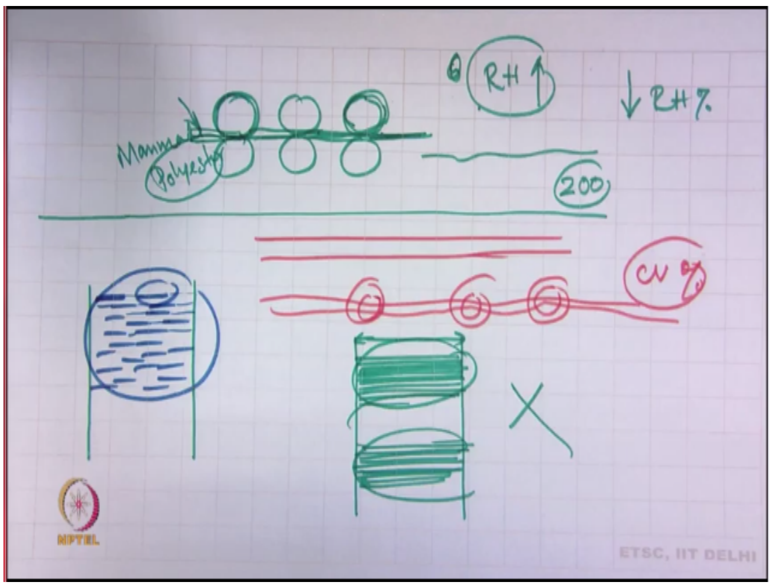

In that case these are the rollers, so certain humidity is there at presence of humidity say humidity is with whatever arrange percentage required it is much more than this. In that case what will happen the fibres during drafting suppose it is if it is cotton it will absorb moisture and then it will try to lap with the roller. So, roller lapping will take place or even splitting of fibre strand or drafted strand will be the, so it will try to stick to the roller, so roller lapping will be there.

In that case there will be unevenness because the fibres motion of fibres will be wrapped here instead of going on. So, even in case of we have seen it has been observed that average percentage is reduced, so at lower arrange problem of static electricity generation will be there.

And due to static electricity that the fibres say like manmade fibres like polyester this typical it it is starts lapping ok.

So, that creates that adds to the irregularity of the final product, so the external reason that machine in addition to the machine and raw material. So, working condition is actually responsible for poor working condition is responsible for increase in irregularity of yarn.

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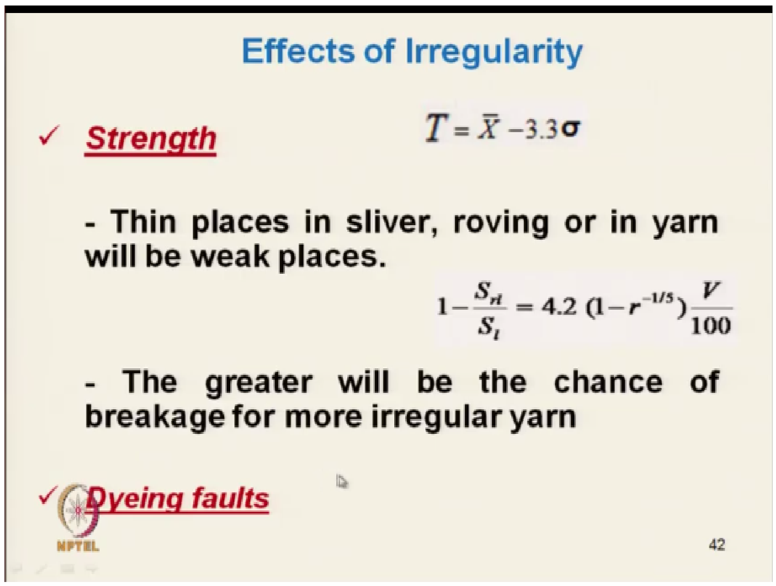

Now try to see what are the effects of irregularity, so effect on strength that we have discussed earlier also. So, the irregularity means it adds to the thick thin places, now 1 yarn this is the uniform yarn ok another yarn it is a non-uniform thick thin place. So, the thin place wherever the thin places are there this will actually this will be the week measure. So, effectively the thin places the breakages occur mainly in thin places, so if we normally it has been observed.

A thick place is followed by a thin place ok, so that means in uniformity if it is low it is that CV % is if it is high that means there will be more and more thin places. So, that will actual result the lower strength of the yarn and in addition to that thin place that uniformity as we have already discussed the uniformity that is in terms of standard deviation or CV% affect the strength and the breaking tension ok.

Another fault is that dyeing fault, so non uniformed yarn means thick place as we have mentioned we have lesser twist and will absorb dye at the higher quantity. Then the portion where the twist is more, so that way it will have actually the product will have the dyeing fault.

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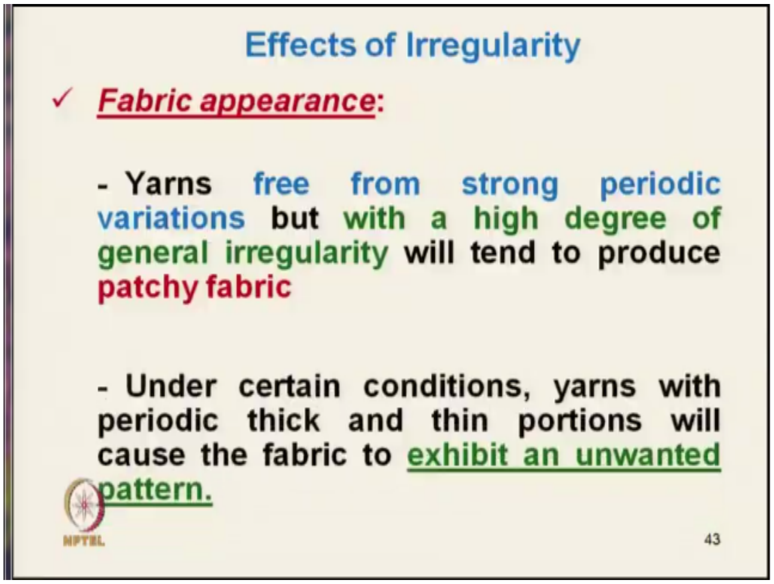

Next is the fabric appearance, now fabric appearance it has got direct relationship with the fabric appearance. The non-uniform yarn maybe in the random uniformity or random unevenness or periodic unevenness, periodic irregularity those they are actually they result poor fabric appearance. So, yarns free from strong random periodic variation that is it is a huge general variation like random variation will result high degree of patchy fabric ok, strong periodic variation.

But with high degree of general irregularity that means U% is very high but it does not have any periodic variation. Now suppose this type of yarn if we use in weft random variation that means that will this yarn this is fabric and in weft and say if it is there I am drawing only thick portion thin portion I am not drawing. So, this will give this type of patchy effect, this is type of effect and rest is the thin patches ok, so random variation.

So, this thick portions will be actually measurable, so that will give this type of patchy effect but still this random variation it is acceptable at least in inferior quality and this will give inferior quality. But we can use this of random variation fabric made of yarn from random variation is little bit acceptable. But if the variation is periodic that will create a peculiar effect which is actually not acceptable which will cannot react ok.

So, patchy fabric sometime we can use we normally use for different application ok and this patchy fabric sometime may not be visible because of the level of irregularity okay. But under certain conditions, the conditions should be there it is not always special condition should be there yarns with periodic thick and thin portion will cause a fabric with unwanted pattern, this pattern is not acceptable.

If any fabric we have me must have seen different fabric of different pattern but this type of pattern is not acceptable.

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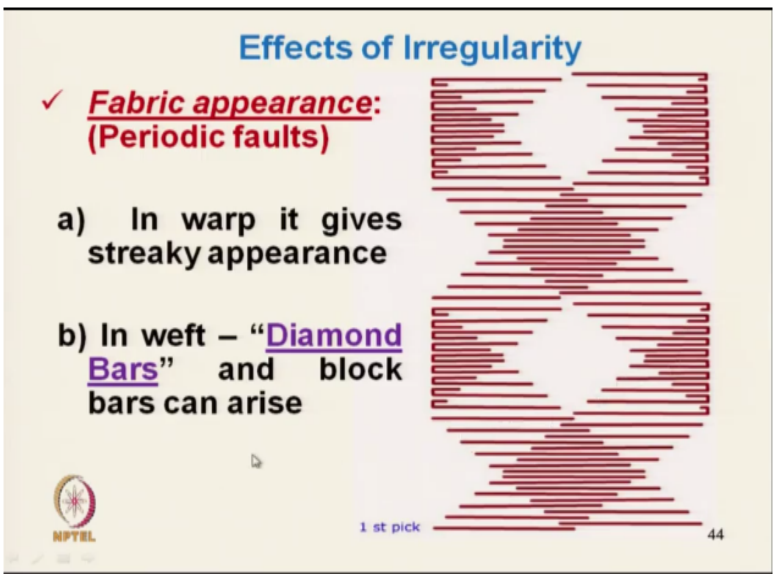

This one of the examples of this pattern is weft diamond ok diamond bars in weft or block bars. Block bars means if the yarn suppose the yarn weft yarn the periodicity is very longer periodic length ok wavelength is very long ok maybe the length of with the wavelength is approximately say 200 times of the width of fabric, 200 times of the width of fabric, very long wavelength what will happen in that case say 100 threads 100 peaks will be course thick.

And **less** standard will be thin this will be thin, then again say thick, so this will give a special pattern bar pattern weft bar pattern, that is not acceptable, we cannot accept. But another type which is known as diamond bar I have discussed, so this will give special appearance which is not acceptable, this is 1 example. This type of pattern will be generated here the thick places are shown by line and thin places are not shown here ok.

So, which is visible, now if we see the fabric ok at a glance if we see the bar weft diamond bar will be look like this. And this suppose this is the wavelength ok and here it is a next this is wavelength ok this is the next one ok like this. And here it is started and again folded then there is nothing, so this type of pattern will be generated. If the continuous weft is being inserted from 1 package ok and here this will only happen for a particular conditions, special condition, what is the condition.

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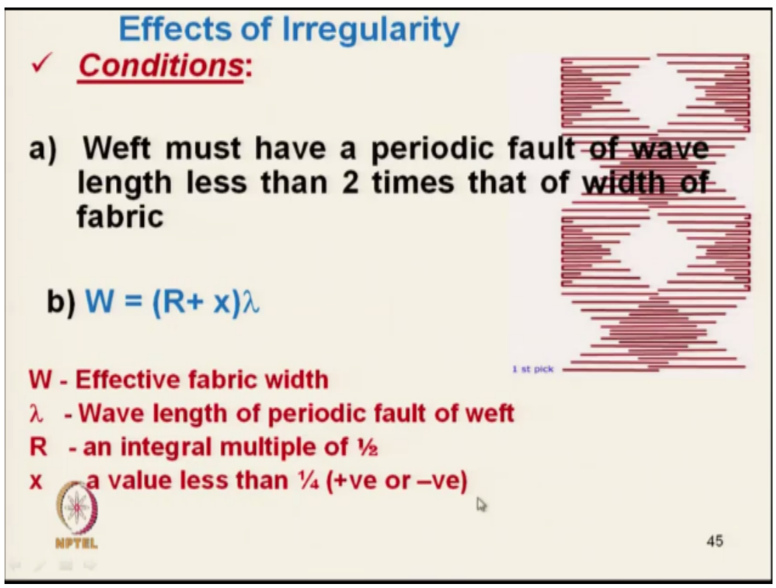

Conditions are the weft must have a periodic fault of wavelength less than 2 times that of width of the fabric ok, less than 2 times of fabric. That means wavelength, the total wavelength should be less than 2 times of the width of the fabric and this is the relationship w, where w is the effective fabric width, lamda is the wavelength of the periodic fault of weft, R is the an integral multiple of 1/2 and x is a value which is less than 1/4 this maybe positive or maybe negative. So, if we can set this parameter will definitely get this type of pattern ok.

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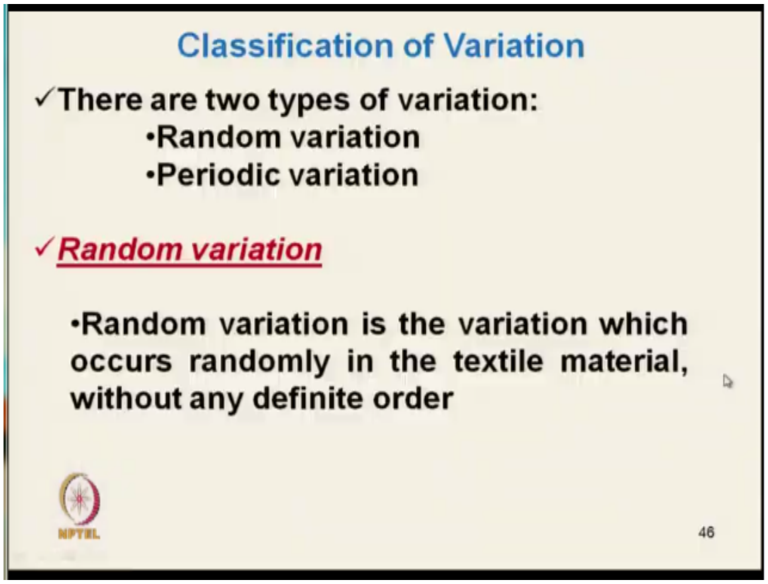

Another effect is that here we if we this type of yarn in warp then also we will get streaky way ok streaky warp pattern ok. Now how to classify the variation we can classify the variation in 2 types 1 is the random variation another is the periodic variation.

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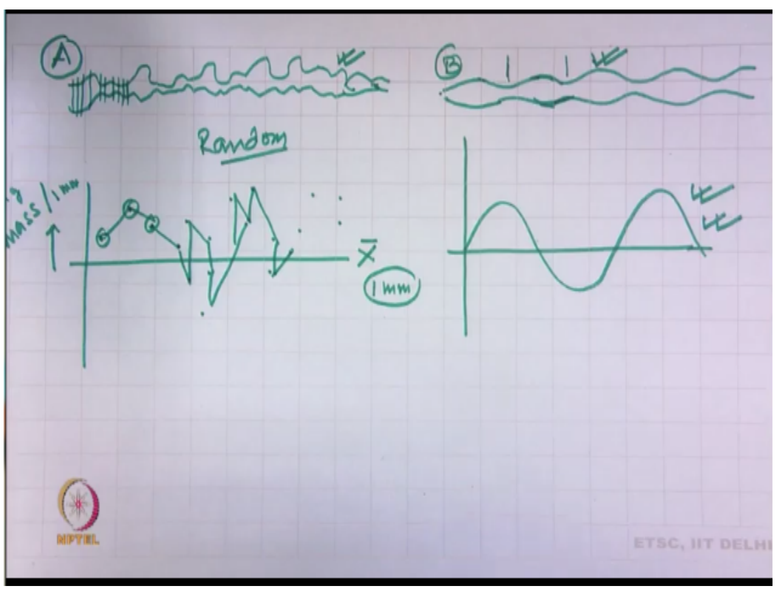

So, random variation this is a yarn which the variation is there yarn A without any pattern, so the variability the thick thin places changes at random order. But another yarn B if we see here this is following a particular pattern after certain length ok the pattern repeats ok, this length is known as the wavelength of the defect. And from looking at the pattern of the variability 1 can make out whether this variability.

This irregularity generated by any inherent defect of a particular part, particular roller ok if there is a defect in particular roller maybe in a drafting roller or maybe in any carding cylinder or maybe in gear ok or dealt. So, the normally this type of defects are actually generated, so periodic faults are generated but for other reason all other reason the random variation is united. So, random variation is that ok random variation here suppose what we are doing.

We know the mean mass/unit length see unit length maybe 1 millimeter, so 1 millimeter length imaginary. So, 1 millimeter length the mean mass is say x bar ok now what we are doing we are cutting this yarn in 1 millimeter length and imaginary we are weigh it. So, this portion is where this will have at different portion, so we will have different mass/unit, this it is the mas/millimeter ok, so milligram or microgram ok per millimeter.

Now if we plot this, this card this is the random variation of yarn, random mass variation ok, now similarly if we try to plot here this yarn will get a beautiful pattern similar pattern, so this is called periodic firm. And it has been observed that the periodic fault we can control by proper maintenance of the machine, proper maintenance proper setting of the machine, proper that in case of gear, broken teeth and the roller eccentricity if we can maintain then we can eliminate this type of pattern.

But the random variation we can reduce by overall improvement in the spinning condition like proper selection of fibre, proper maintenance of the environment. So, everything we have spinning culture, so that we can reduce the random variation ok. So, random variation is the variation which occurs randomly in the textile material without any definite order, there is no order.

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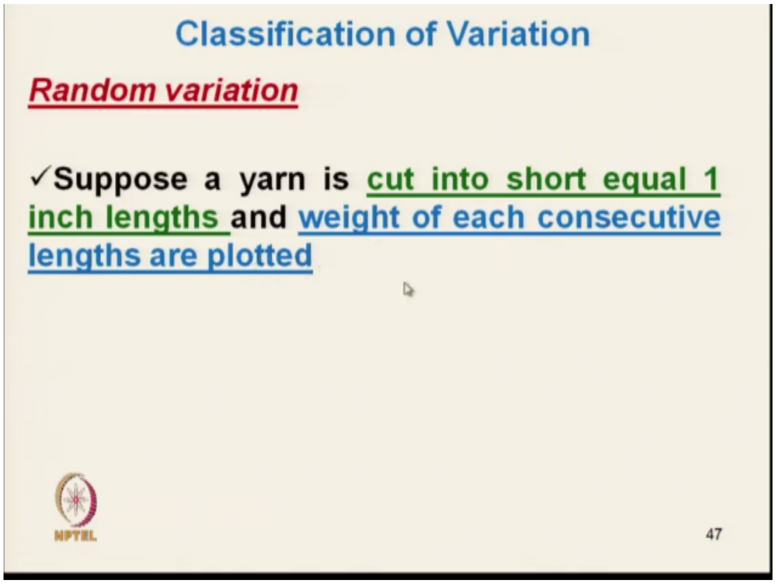

So, that we have mention that suppose a yarn is cut into a short equal length of 1 inch and then take mass ok, consecutive length. And then plot it and then if we join this points will get irregular **trace**.

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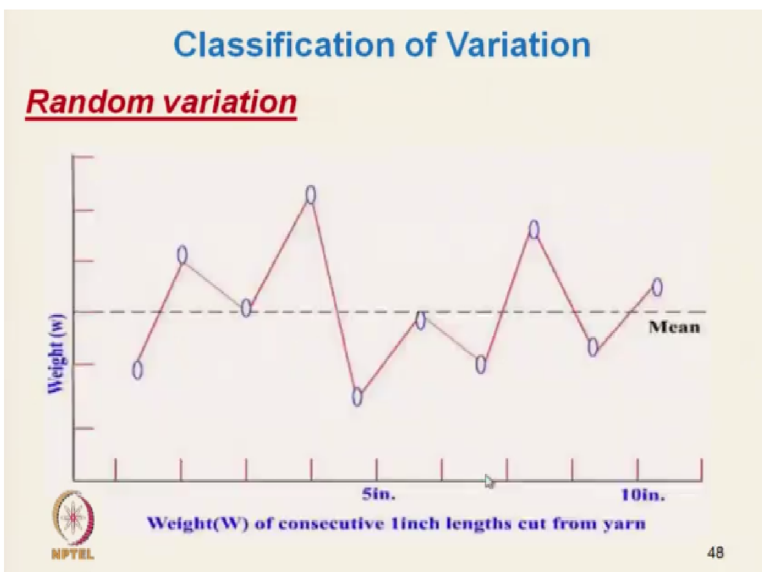

So, this is the irregularity trace of random variation.

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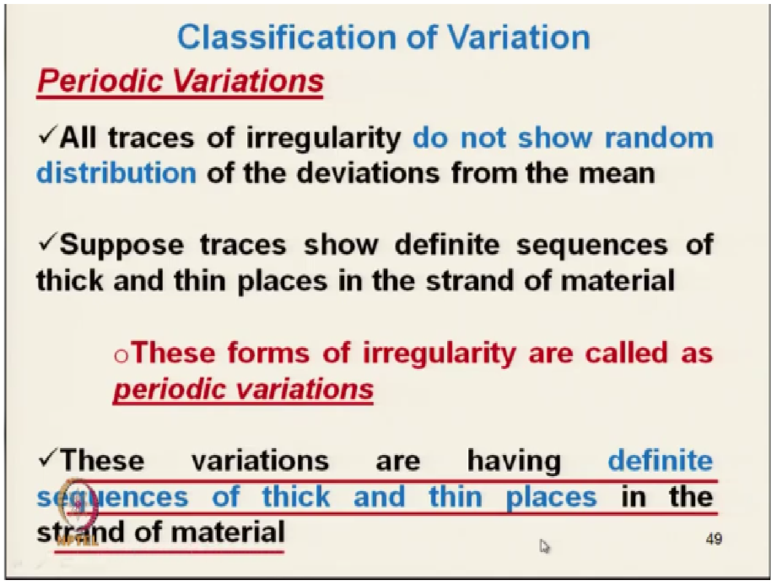

Similarly if we take the traces of periodic variation will get a particular order ok, this form of irregularity as called periodic variation. And these variations are having definite sequence of thick and thin places in the strand of material ok that we have seen ok.

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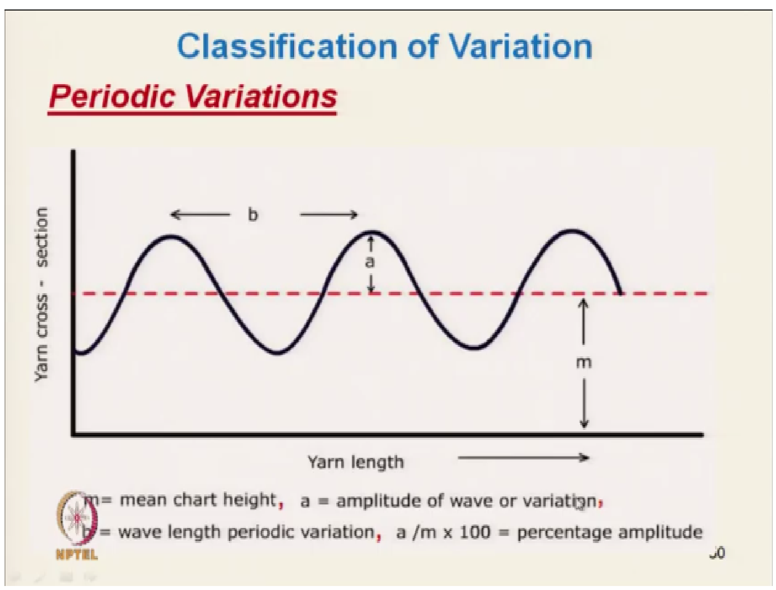

This is the relation where this b is wavelength, a is the amplitude ok and m means the mean this is the mean height ok mean value. And percentage amplitude is a/m*100 what if it is given suppose and the one has to measure the percentage amplitude this is the amplitude. Now what does amplitude show, the amplitude is actually it shows the severity of the variation ok.

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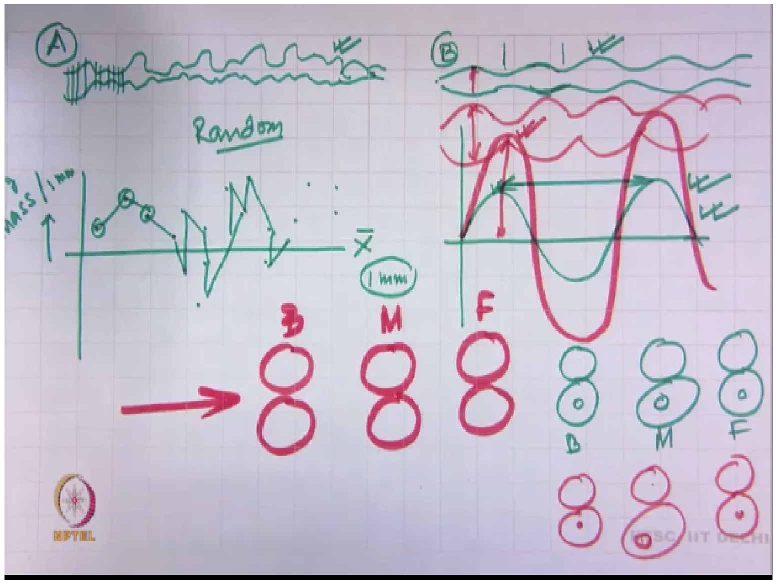

Now suppose this is 1 yarn and another yarn is with same variation, same wavelength this type and suppose now that it is actually it is generated from suppose 1 particular roller, this is front roller, middle and back roller, this is the material. And here this is normal material normal and now I will draw the defective roller for this green color curve ok. The material is same it is producing same material, in 1 machine it is getting this type of plot green another machine it is giving this type of plot.

Now both are giving the periodic fault now this green color it is getting due to the say eccentricity of the this middle bottom roller ok. Now the from this wavelength we can locate the fault that we will discuss ok how to locate the particular machine. Let us for the time being let us assume that it is a from the middle roller, this is the front roller, back roller, they are perfectly circular, now this is the situation.

Now next is that the ok next I am trying for the this yarn ok this material now this material perfectly circular no problem and top roller there is no problem. But bottom roller the eccentricity will be much higher that means this the roller eccentricity or roller bend whatever that directly reflect the amplitude. And if we see the yarn if we compare this is the green yarn the radial will be like that this is the amplitude ok.

So, that resulted by the severity of the defect, so defective part that we can see from the amplitude and higher amplitude means higher actually the visible defect.

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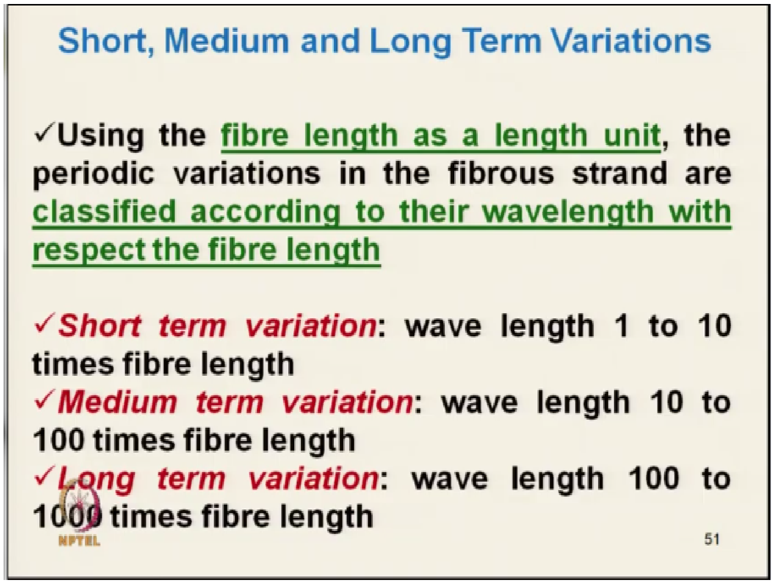

Now we can segregate the variation in terms of length and this is done with reference to the fibre length and this variations are called short term variation, medium term and log term variation. Using the fibre length as the length unit the periodic variations in the fibrous strand are classified according to the wavelength with respect to fibre. If the wavelength of variation, wavelength of periodic variation we are talking about the periodic variation it is a if it is the wavelength is 1 to 10 times of fibre length, that is called the short-term variation.

And medium term variation is say 10 to 100 and long term variation is say 100 to 1000, now let us see **let us see** our fibre we are using say polyester it is of 50 millimeter suppose.

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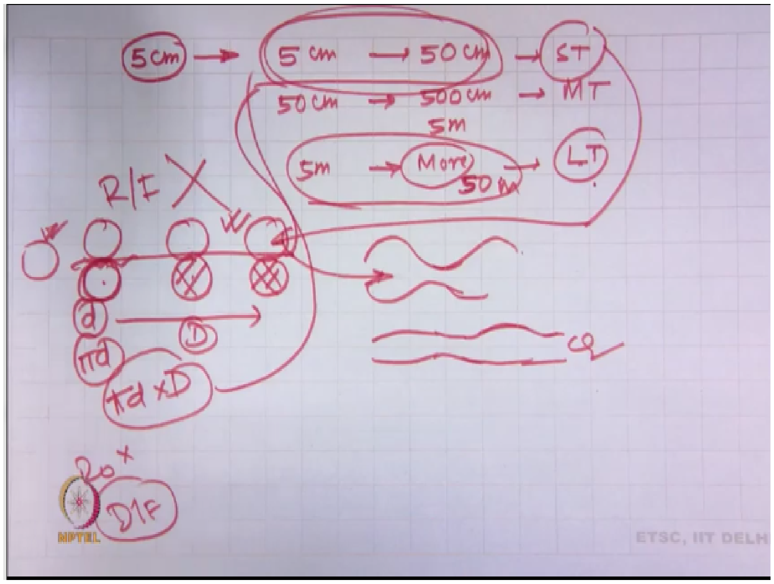

The 5 centimeter fibre length means it is a if the wavelength is between 5centimeter to 50 centimeter that is called short term variation ok. If it is say 50 centimeter to 500 centimeter that means 5 meter it is will medium ok and if it is say 5 meter and more it typically say 5 say 5 5000 meters, so 50 meter, so that will be it is a long term 50 meter ok, 5 meter to 50 meter it will be long term .

Now a machine which is suppose in ring frame if ring frame produce any defect due to it is malfunctioning due to mechanical problem. So, the wavelength of that defect cannot be long term variation, wavelength of the defect will be definitely in this sense 5 to 50 centimeter. If we take care of defect in the roller anywhere gear. So, if it generates suppose it back roller it is generates it will be =say diameter is d.

So, the wavelength at this point will be pi*d* draft total draft, so pie d*total draft it will be within this zone. Whereas if there is a long term variation 5 meter to 50 meter that cannot happen in this ring frame that will be further backward either in roving definitely not roving it maybe in draw frame, long term variation will be in the draw-frame. So, it has been observed that the defect which is actually taking place or generated at the later stage.

There is a least chance of getting rectified the thick thin places will get will be least actually chance will be getting the rectified. So, the defect which is generated at the later stage like ring frame the amplitude will be very high ok relative amplitude will be very high. On the other hand if it generates at the later backward portion. So, then in that case this defect will get little bit actually compensated during subsequent processes, so the amplitude will be less.

So, from this it has been correlated that short term variation is basically from the later stage and that is related with the higher amplitude. And long term variation earlier stages with the lower amplitude suppose in carding some defect is taking place, so this defect will get actually minimized in draw-frame by doubling and so it is it will get averaged out, so amplitude will be less.

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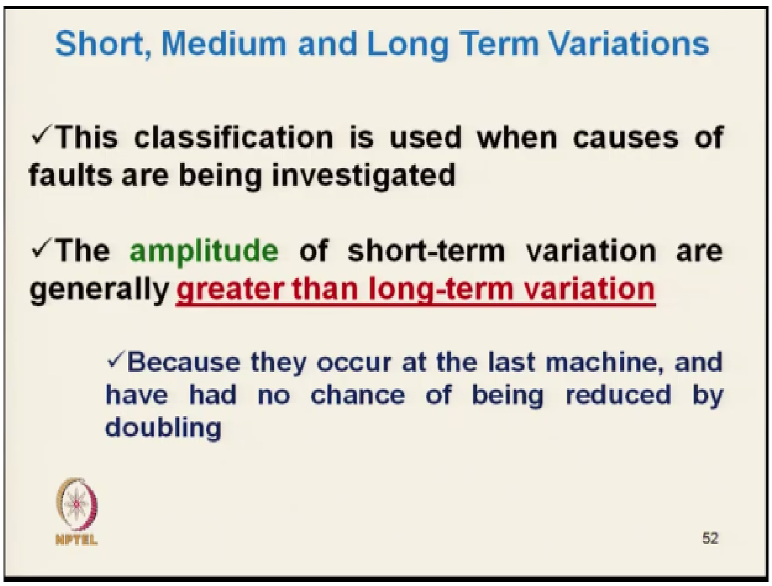

So, this classification is used when causes of faults are being investigated, so what is the causes which machine which instrument is which machinery part is actually responsible. So, from there from short term, medium term and long term variation we can make out, the amplitude of short term variations are generally greater than long term variation. Thus I have explained just now because they occur at last machine.

Short term variation is always they occur at last machine, so looking at the wavelength we can make out we can guess where in which machine is generated. So, in that case and if we go in depth that we can locate, so that is the reason that is the way we use the spectrogram analysis from there we can actually we can locate the fault.

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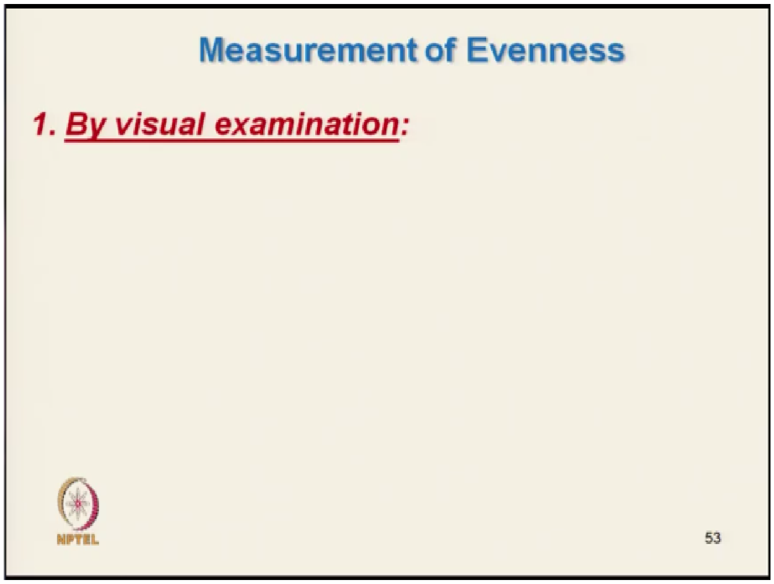

Now how to measure the evenness, evenness is measured by different techniques, so easiest technique and the old technique is that by visual observation ok. So, by visual observation this is actually measured like suppose this is roving ok

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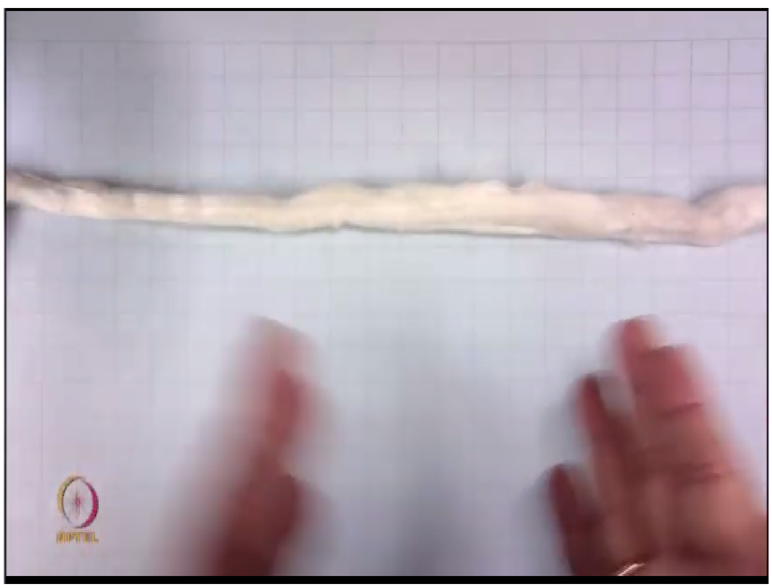

Now by visually you can see this is uneven ok and if we compare with other standard sliver this sliver is totally uneven. If we compare with another sliver which is perfectly even we can say this one is better than this present way. So, visually we can compare the unevenness of different material, so we will discuss the various techniques of measurement starting from visual technique or cutting technique cutting and weighing technique. So, all these things will discuss in the next class ok till then thank you.