Mining Machinery
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Module - 09
Lecture - 47
Belt Conveyor Design Criteria

Welcome boys and girls. Today, we are going to discuss about the Belt Conveyor Design Criteria. In our last class, we introduced conveyor belt and you have learned that in mining transport conveyor belt has got a major role and they are used in different operations.

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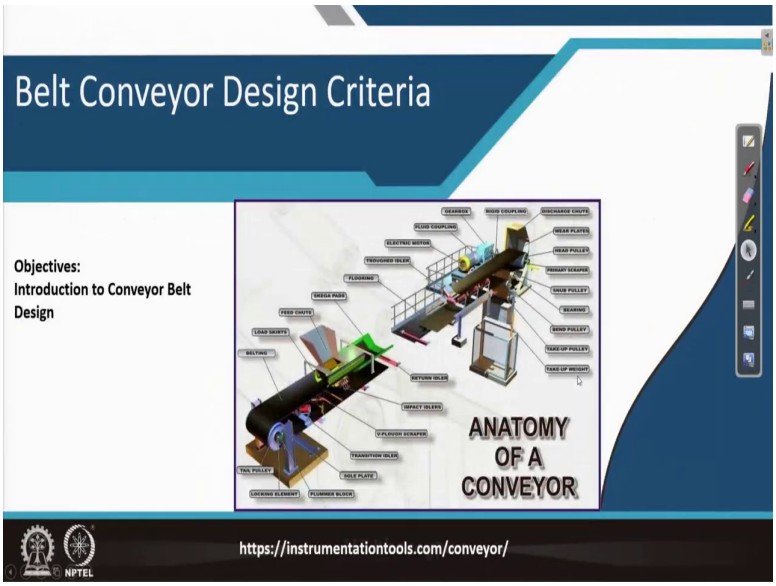

So, to design a conveyor belt or to prescribe a particular belt for a specific installation you need to know what are the belt conveyor design criteria. And so, that after that you can do some small design exercise so that to at least to calculate the basic parameters required for a

particular given installation. And, for that we will have to today just discuss few design criteria and then in the next class, we will be doing the conveyor belt calculations.

So, coming to our basic purpose of this or objective of this lecture is to introduce the conveyor belt design exactly how this conveyor belt are designed. In our last class, we have discussed about the components of a conveyor belt. Here you can find a lot of different type of diagrammatic and pictorial representations of the conveyor belt.

This one which is given in this website instrumentation tools dot com conveyor because that what are the basic components and parameters. These are necessary to know that if you want to do an automated conveyor belt, if you want to do a proper data analysis of the performance of conveyor belt.

If you want to improve the conveying economics or if you want to improve the reliability and quality of services of conveyor belt you will have to do this all the components are there.

Now, we will be designing in our next class about that is drive motor. Here a gearbox and the drive motor is there. What should be the power of this motor so that this conveyor belt can be driven? You can see here we are having this head pulley; that means, that material will be transporting in this directions. This is the discharge shoot is there material is discharged at this point and you can see this conveyor belt at carrying inside.

These are three idlers separately low placed not in a garland, then you have got this return idler a single idler. So, the troughing is made by this angle of trough is mentioned here and then of course, this is supported on a structure.

This structure has got a platform, a walkway by the side people can go and you have got the tail pulley. You have got this attentioning arrangements, you can see here there is a hole take up pulley that is to take up the tension. So, all these things are there which we have discussed in the previous class.

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Now, today let us explain what are the main design parameters and then how to identify the various influencing factors that affect these parameters and how to use this parameters in designing a belt conveyor and then how to improve the existing belt conveyor.

Our objective of study is when you go to the mining industry if or if you get a job in the mining companies, then once you go there you observe it. By seeing that you can find out that these are installation 10 years, 15 years, 20 years ago. So, now, some of them can be improved by retrofitting some systems or some of them may require a discarding because they may not be energy efficient, they may not be environmentally friendly.

So, at some time we will have to face them out and we will have to improve new modern and the quality and reliable economic installations. So, there you will be as a managerial study,

you may do a lot of your cost benefit analysis of such type of changes and all, but before that you must know the technology.

If you do not know the technology you cannot apply computers, you cannot apply this your managerial techniques to improve the system.

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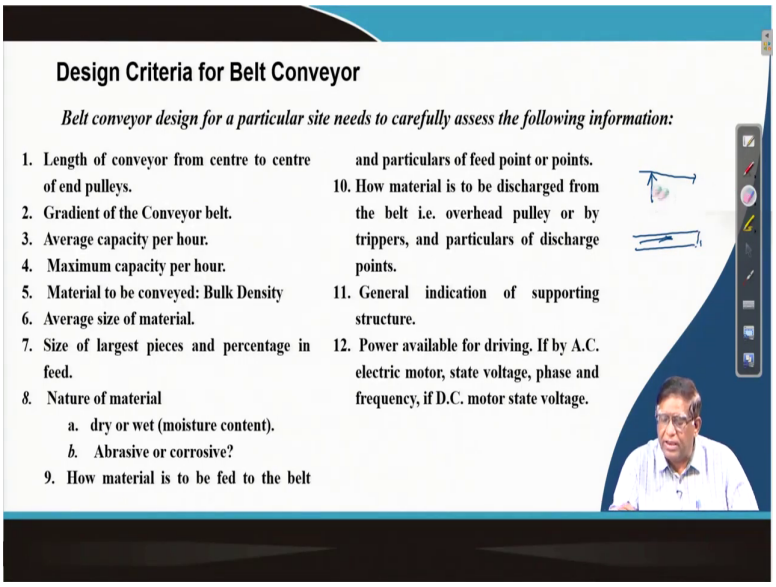

So, for that let us know about that if you are to go if you have to design a conveyor belt, what are the main parameters that need to be knowing that, you need to know what is the conveyor centre to centre distance where the pulleys will be placed over there that is one parameter. You need to know the gradient of the conveyor belt at what angle it will be there, then what will be the average capacity per hour how much it will be carrying.

Then what could be the maximum capacity it can carry, what type of material will have to be conveyed that is – what is their bulk density. What are their sizes? What are their shape and then what are their chemical properties, how they abrade the conveyor belt these parameters need to be taken into consideration. And, what is the average size of that bulk – as a last class you have seen that the size has got restrictions on selecting a particular width of the belt.

So, whether your raw materials which are coming to be conveyed are they compatible with that, then you have it will be affected the design will be affected by the nature of the material whether it is a dry or wet or it is a corrosive, then it will affect differently. Then how this material is to be fed to the conveyor belt: while you are designing a conveyor belt whether you will be dropping for a top, whether you will be feeding from the side.

That means, this belt is going in a if the belt is going say for example, the belt is going in a directions of in this direction and then if you are just going to load the material coming from the other direction is it coming from this directions or this conveyor belt is moving like this and then your materials are also being loaded over here. So, that means, you are you are having from the top you are loading on this this will be affecting the how exactly you will be running that is driving the conveyor belt.

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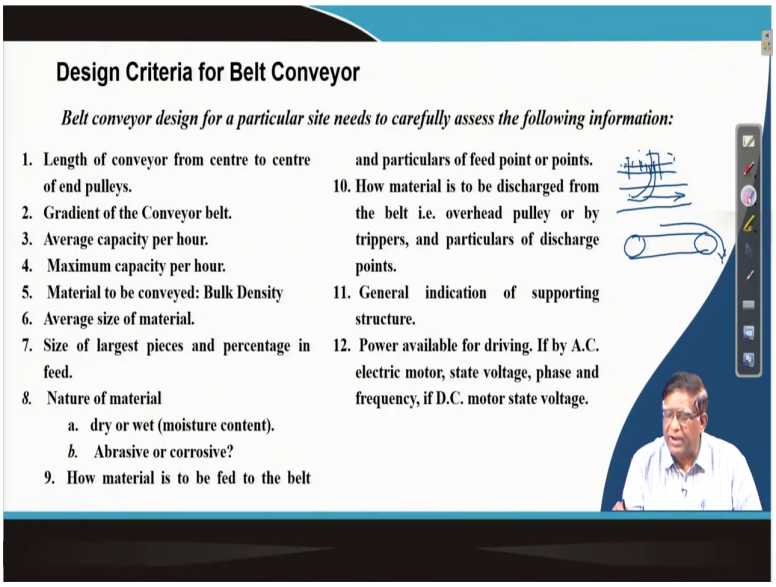

So, designing of the conveyor belt will be depending on that is your the way of feeding, then how the material is to be discharge from the conveyor belt say as the material will be going from your conveyor belt.

If your material is going like this direction say on a belt conveyor belt it is going like this, now the material are you discharging it here or from here itself you are discharging the material over here, so that you are dumping the material over here.

So, this depending on that is whether the charging at a one side or you are taking it you will have to have a different type of systems over there. Similarly, what is the supporting structures where you will be putting the material, then how much power will be required that

is what is your what type of if it is a AC motor or DC motor what are their motor power requirement.

Today, let us discuss about this criteria. The number 12 criteria will be discussing in our next class, where we will be this is we will be studying the where we will be studying motor power separately, ok.

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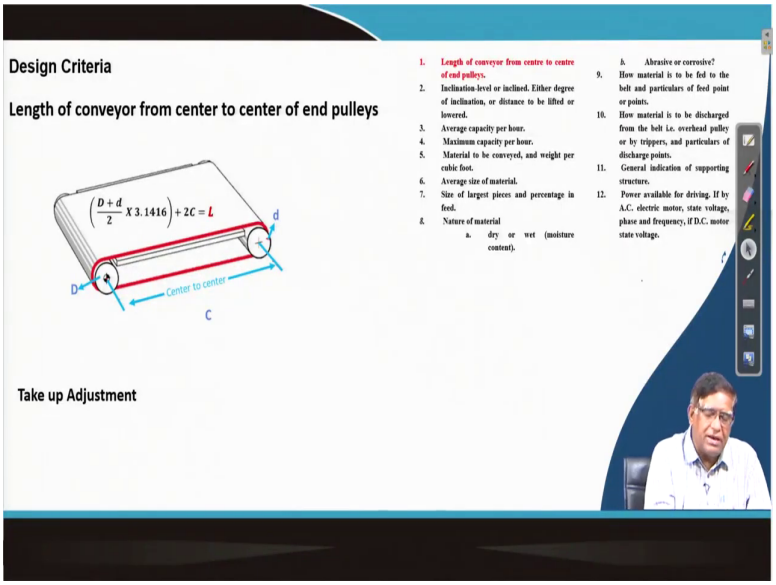

So, coming to the next unit we are taking the first criteria that is your length of the conveyor from the center to center end pulley. Now, this criteria of your lengths of the conveyor you can see that there is a from one this is a one end pulley, this is another end pulley; for simplicity you see as if it is a flat belt over here

Now, what is our most important thing is there, what will be the total length of the conveyor belt? It is very important that is the center to center distance of this two pulley, it will be having this your the main defining criteria wherever your site is there where you will be installing your conveyor belt there, where will be your drum location from that drum to locations their center to center distance this could be your 100 meter and sometimes it could be few kilometre.

Now, depending on that your conveyor belt length will be there, but between that there could be number of other supporting pulleys and all that thing. So, in every simple case you can see that by the diameter of these two pulley that will be giving you that length. So, that is your total conveyor belt.

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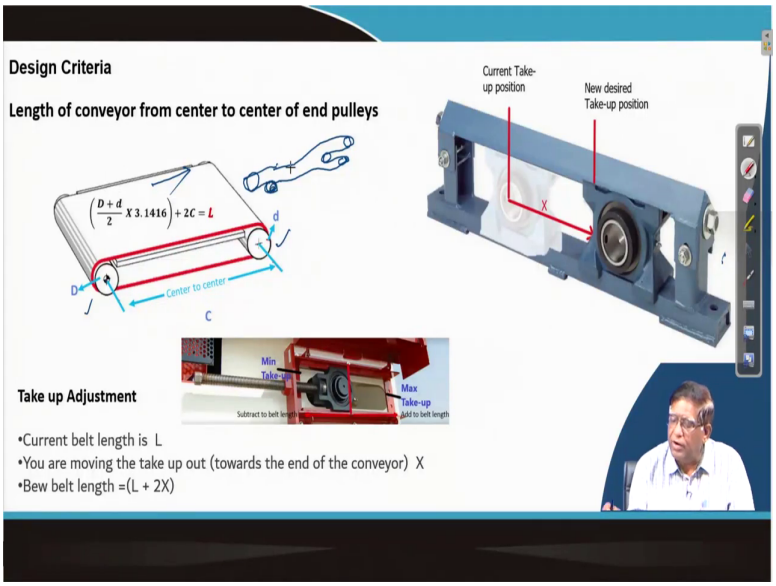

Now, so, the first design criteria we are talking about is the length of the conveyor from the center to center of the end pulleys. You know here that we are having this that one that is your discharge end pulley and this is your the tail end pulley if the conveyor belt is moving in this directions.

So, whenever in any installations you have to do a conveyor prescribing we need to know that what will be the length of the conveyor belt you require. So, this length is determined say by this formula you can find out that is a center to center distance. Now, in a particular locations as you have said earlier that the profile can be different.

A conveyor belt may go in a different profile and then they may have got a different type of drive and then it will be coming. We can have that is your we can have this system that is your depending on the depending on your conveyor belt design profile you may have got a total length is different.

So, that will have to be calculated and determined very carefully at the time of prescribing the use. So, but in that one thing you should remember, that other than that the take up also make a difference in the length of the how much it can adjust. A screw take up system in a screw take up systems.

You have got this much place which is exactly will be taken as a take up it can come this way or if it going like that you will have to take subtract that much from the length.

So, that is it is a very simple thing, but you should not you should take into account while designing the conveyor belt.

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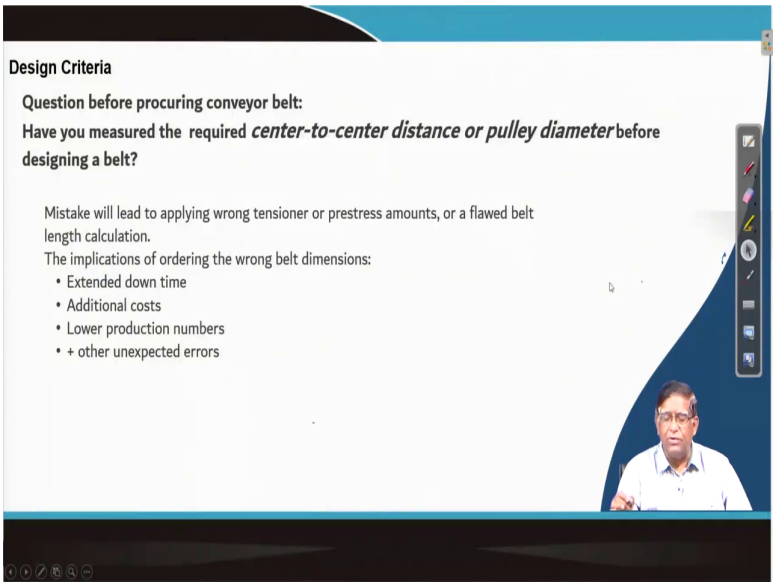

Now, this other thing which we will be knowing about here that say our design criteria we will have to ask the question before procuring conveyor belt is how you measure the required center to center distance or pulley diameter before designing the belt.

Because if you do not do this if you do not very carefully select the center to center distance, then you may be ending up with a particular conveyor belt. When you are joining it together that is a your that you after doing the vulcanizing or belt clipping or joining two belt, you have got a closed loop.

Now, in that closed loop you have got the two and drum location is fixed and your this take up distance is fixed. So, then if you have not done the things very carefully, then there will be having a problem this conveyor belt may slip, the proper your power transformations will not

take place. So, you will be having other problem associated with it because now this will lead to a downtime of the converter.

That means, the total capacity utilizations availability utilizations will be going down and then there it will exactly lead to a additional costs. So, that your the productivity will get down because of this what is necessary that you will have to take the this as a distance design criteria your length and the distance, the locations of the end pulleys will have to be properly fixed.

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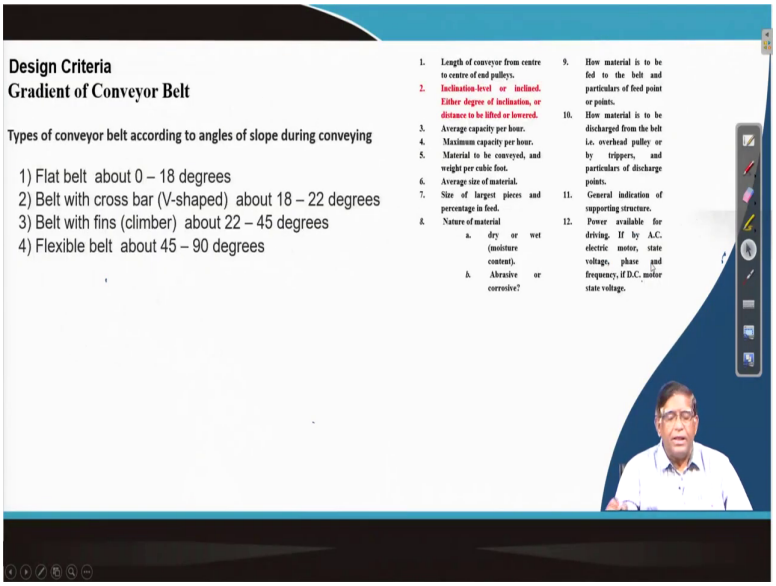

The next thing is your inclination that inclinations of the conveyor belt that is how the gradient there could be four situations are normally given that is a flat belt.

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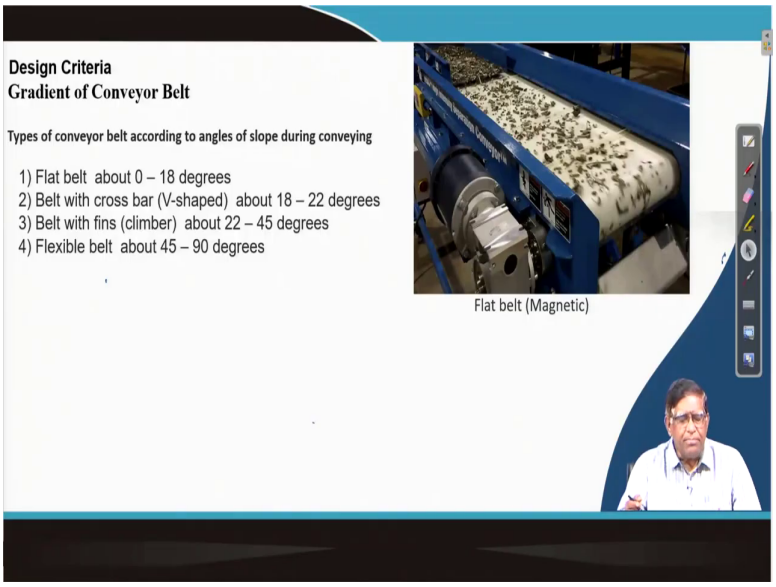

And, then in a flat belt you can see here that is it is a of course, a magnetic belt. Flat belts in the mines you will be seldom using you will not be using, but they up to 18 degree sometimes this this type of flat belts are used.

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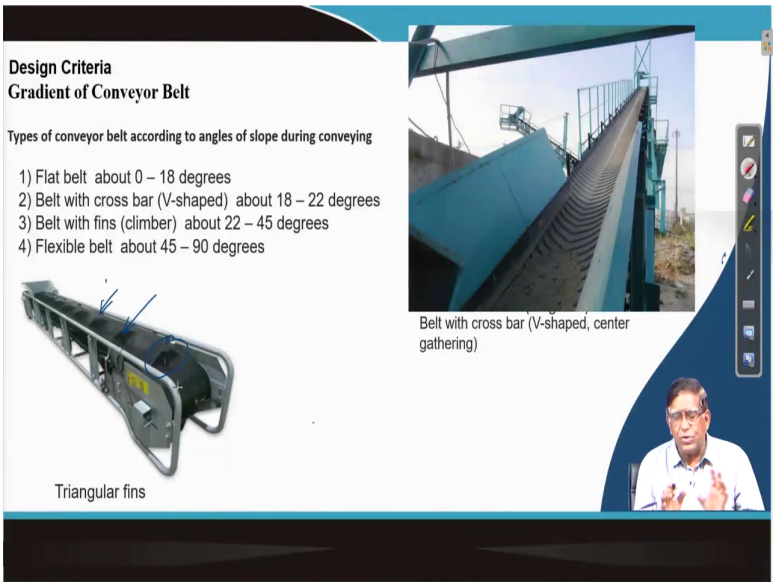

Then there would be some troughing belt. Now, this troughing belt here in this particular one you are seeing a cross bar on the belt. If it is you are going to up to 18 to 20 degree depending on what are the type of material even if the material slides they will be protected over here you are having this cross bar.

So, this type of special belt design can come an in which you can use the conveyor belt without maintenance trouble and on a higher inclinations for getting better utilization.

Similarly, sometimes you can see that if you have to use it 22 to 45 degree, there you are having climber. You can see here that is your you can see in this ones that here you are having some this your this this your a triangular fins are fixed over here. These triangular fins they

exactly retain the material so that the material can climb upward. So, this type of systems are there.

So, while designing when you have studied you are going to study your requirement in the field, you will have to take up that which designs could be taken up.

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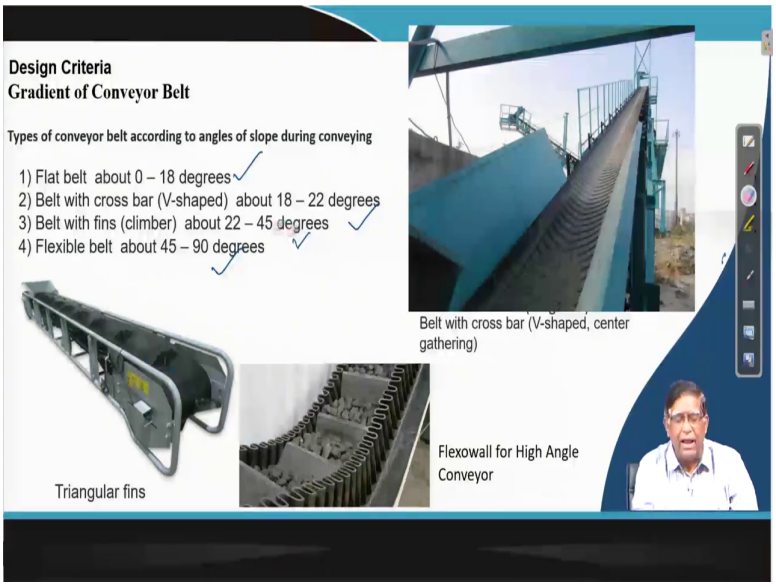

So, similarly this other things that sometimes you need to go for a this 45 to 90 degree if your this conveyor belt you can see here a high angle conveyor which is a very flexible belt where you are using a flexowall. These are the first Hoorays company in the 80s itself such type of belts came up; nowadays even the Ropecon and other developments they are using this.

So, this is where you can see the box. So, the material is retained over here and it practically up to 90 degree it can carry this material. So, while you are going to design a conveyor belt at that time you need to know what is that inclinations exactly you are going to work with.

If the working is it is within the 18 degree, within 18 to 20 degree, within your 45 degree or it is above 45 degree and depending on that you will have to select your this conveyor belts belt design belt part will be coming into there.

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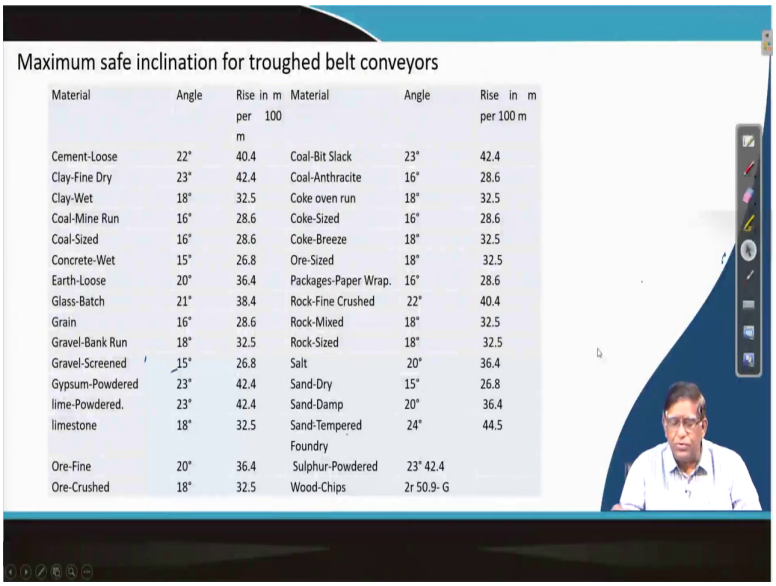

So, next thing is if you want to see that is your different angle, the materials can be carried differently. There as you as you already know that whole design of conveyor belt is standardized by Conveyor Engineering Manufacturer Association CEMA and that CEMA

handbook which is that I think 2015 edition is the latest editions. You can even download you can read that at e-book can be read over here over in the net also it is available.

You should see for our type of material whereas, a run of mine coal it was up to 16 degree it can rise as a as a gradient; that means, 16 degree means 28.6 meter in 100 meter that is how the gradient it goes. So, different material can go with a different things. You can see here the that ordinary conveyor belt uses this is having a limitations of the inclination. So, this type of data you need to collect.

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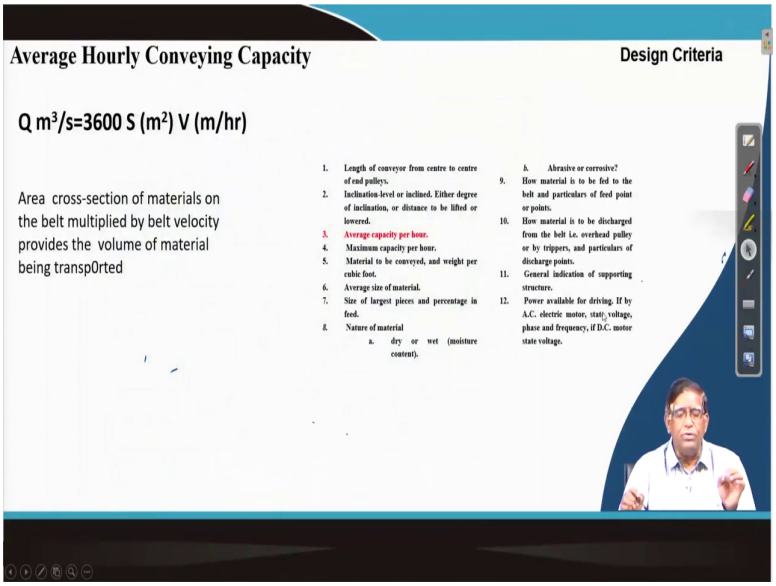

So, after you know that is your what is that width and of the belt and that is exactly what is the capacity of the belt will be depending on the speed and the material. Here exactly you can see here this is our how the capacity of a conveyor belt will be determining.

It will be determined on the basis of how much material is there on the top of your conveyor belt, that is, your if your conveyor belt is you we have already known that on the idler we are having that belt on the belt we are having this material is kept over here.

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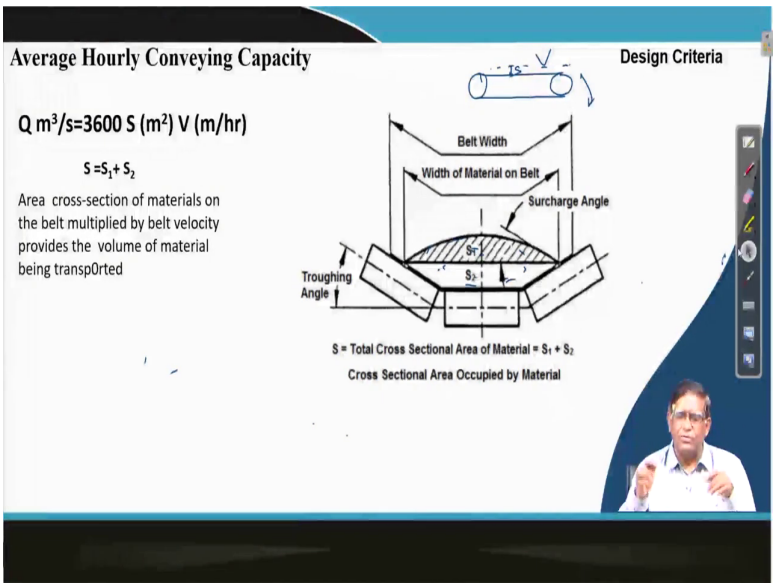

Now, the material if you see that cross sections of the material it can have a trapezium and there is a circular sections. This together this whole area is the S 1 plus S 2 is the total area of cross-section. Now, how much material exactly this conveyor belt? If this belt is moving like this and then it is running with that velocity V.

And then if the material which is over here there this cross-sectional area is S, then this S into V that is your that much meter cube per that multiplied by 3600 gives meter cube per second this much material will be discharge.

So, this is exactly an average hourly carrying capacity. Whenever we will be doing any conveyor belt design problem at that time we will have to take this the average hourly carrying capacity because that is how the target is fixed. So, in an open case mine say for example, Neyveli Lignite when we say that 10,000 ton per hour overburden will have to be carried.

That means, 10,000 ton per overburden or return then how much exactly it is meter cube you can find it out by that is you are dividing it by the density. And then if you know that much then you know that how much volume of material will have to be retained over there, then you can know that what is the conveyor belt which now that is if the you have designed the motor power to take that much ton, but your density of the material is very less.

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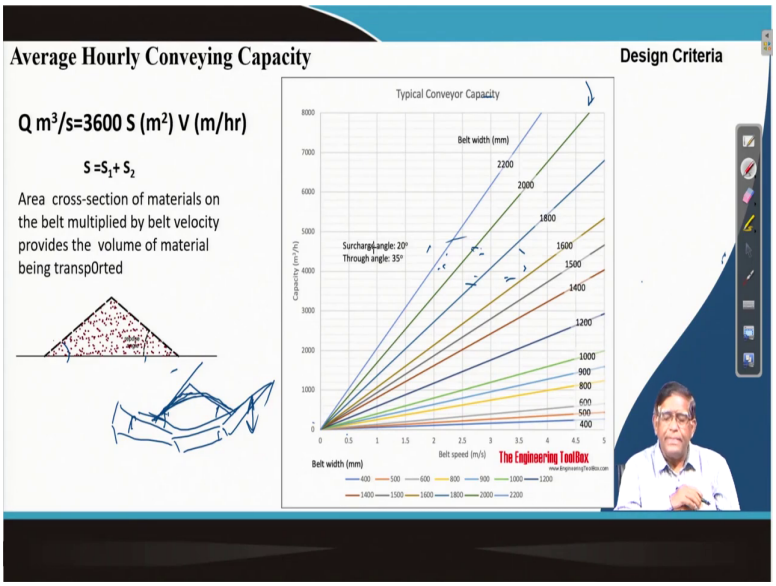

Say for example, you want to get a 10000 ton per hour of coal density is very less, then there will be a huge volume. So, this material volume will have to be very big. So, at that time we will have to take that exactly which one will be taken care of. So, that is why in this the two things are required that is the density is very very important. The other thing this area of cross-section which is determined this area it is exactly one property called your angle of repose.

Angle of repose is that by naturally when you a loose material is dropped from top that what angle it make. So, this angle of repose is very very important and then there is a there is a another thing called angle of surcharge. So, when this conveyor belt will be that is when a conveyor belt the material is there, the material will not be remaining like this.

What will happen? Because it is moving on this idler when there idler it is moving every time on the idler it is getting a movement up and down like that, it is climbing up going down. With this movement there is a settlement of this and it will take a move like this. So, when it is coming like that then that tangentially that angle will be a different angle that angle is called your surcharge.

We can define as if that is dynamic angle of repose that is the angle of surcharge. So, that along with the surcharge angle a conveyor belt average capacity a different different dimensions of your this different dimensions of your conveyor belt width different width of belt will be giving different capacity.

Now, this relationship with your and then the speed and also with your troughing angle, these are the things which is taken care of in the belt design and then also this will be affecting how much exactly motor power required. So, this is the point where we will have to study about this.

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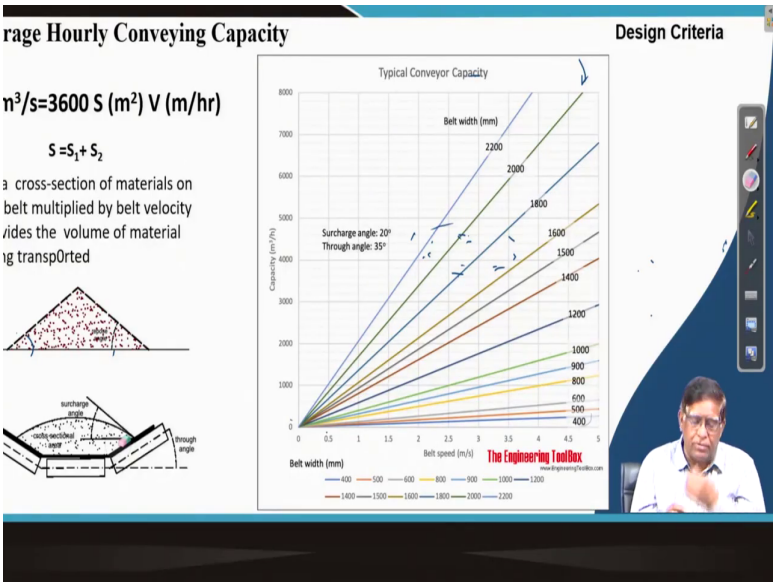

This is another design criteria. As we have seen that here surcharge angle of surcharge you can see here that is your this trough angle this trough angle and angle of surcharge and cross-sectional area. These three things they determine what will be the area of cross sections this S on the thing. Now, if it is a flat belt there will be a different cross sectional area, if it is a troughing belt and you need to do the calculations for these purposes.

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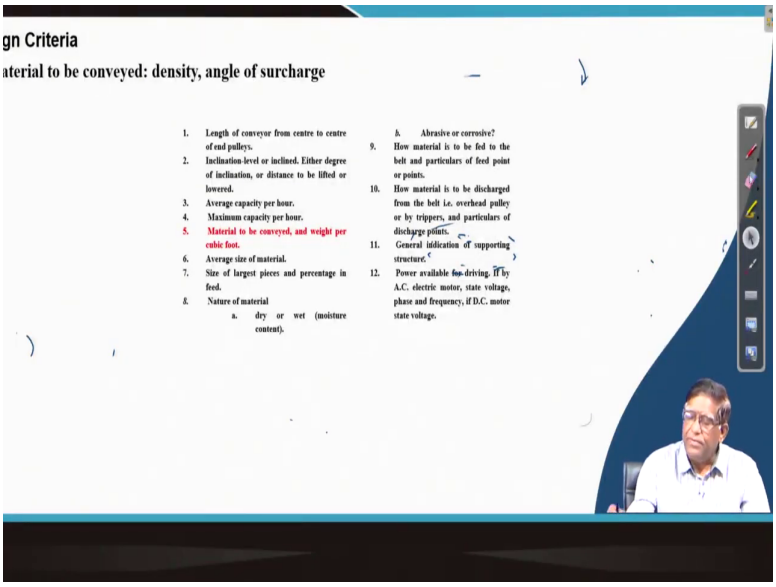

So, other than that when you go to next is your how much material will have to be conveyed at a density their angle of surcharge the material property that affect the things for your this is the total transportation by conveyor belt. The material property is very very important.

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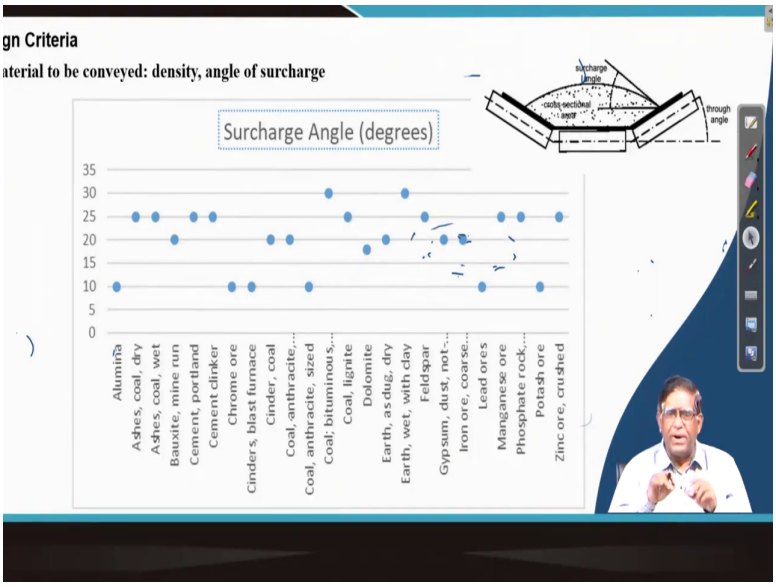

So, now you have seen that the angle of surcharge different material has got different angle of surcharge. Say for example, alumina their angle of surcharge is 10 degree because they have got flow ability. If there is a flow ability on the conveyor when it is there they will be just trying to settle like that.

Similarly, you can see here the coal bituminous coal it go up to even 30 degree surcharge. It can go most of the things you can see within 10 to 30 degree it is there, if you think of this your anthracite coal they have got a different things. If you think of the manganese ore they can go at 25 degree.

So, different materials there is a method in normally in your rock mechanics laboratory or in the bulk material handling laboratory, you determine this angle of repose or angle of surcharge and then do it. Any mines, when they are going to starting their equipment

selections before equipment selections their property and the machinery compatibility need to be studied and those are exactly done in a laboratory experiment.

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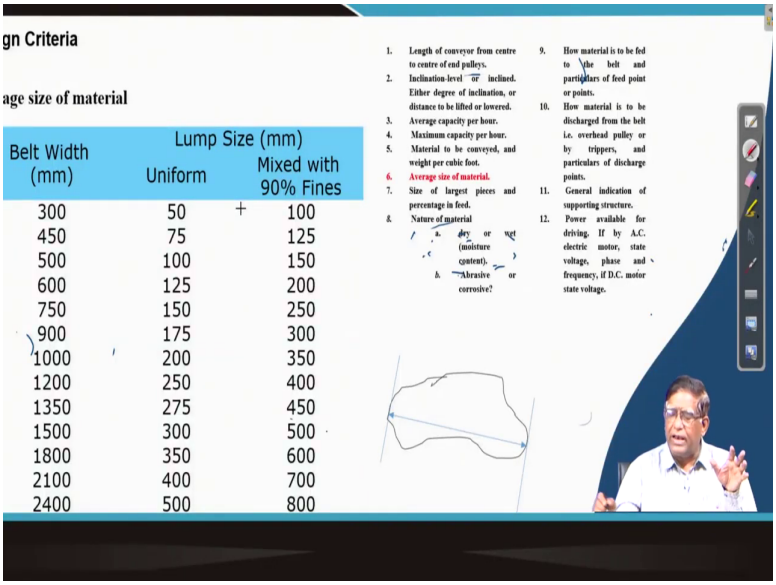

So, this is where you know that the next criteria is your that average material size; that means, your this material that it will be coming after is a blasted material run of mine is a blasted material.

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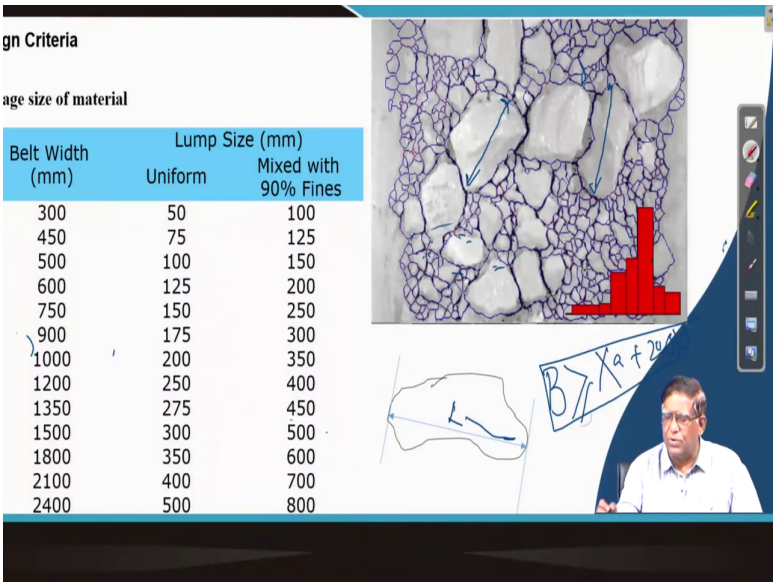

Now, that blasted material in a is a big boulder if it comes you cannot put it to the conveyor belt. So, that how exactly you take the size of the material that is exactly nowadays through a image, by taking photographs you can see here that what are the particle size and their particle size distributions can be determined. And then we can do an analysis by image processing, we know what is the type of blasted materials are coming up.

And, normally the this is your the lump size that any lump size there this this length is exactly diagonally the maximum length is called the size. Say here in this one this may be the one lump size, this lump size may be this ones. So, like that your different lump sizes are determined.

Now, as yesterday we have shown that your belt width it should be greater than equal to that is a X a plus 200. So, that equation which was given yesterday as a limit of use of conveyor

belt it is there and there the CEMA handbook. They give some of the prescribed as a thumb rule, if your belt width if you are going to use a 2400 millimeter belt width, you can have a uniform lump size of 500 meter.

Or if it is a mixed material like this there up to 800 millimeter at least 90 percent it finds 90 percent smaller particle 10 percent like that big lump also can be accommodated on that conveyor it is shown over here. So, rest of the thing is we have got lot of other criteria as well.

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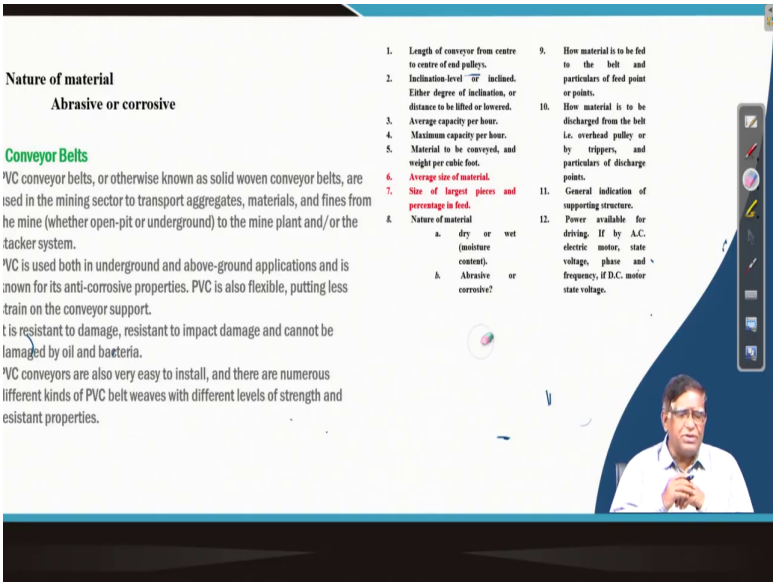

So, if you see that is your how the your abrasivity or corrosivity will be affecting. So, that means, the type of belt which will have to be selected that selection of the belt it is a the material. Many time polyamide, armide all those materials are also used. The conveyor belt design that is your the top cover that is it is always given with some PVC type of cover you

have seen. Now, depending onto the on the uses your this that is the depending on the material property you will have to select this material property.

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Now, the in a PVC belt you can see that in any PVC type of belt here, most of the conveyor belt will be looking like this a black cover PVC belt. Now, inside this belt there is the exactly we are having the carcass. Now, in this carcass this carcass is made of this your solid woven that fabric or steel cord.

Now, in a solid woven there will be number of plies that we have said. So, you will have to be careful in designing how you will be prescribing, what will be the carcass and what will be the top cover depending on the material.

Now, if you see that this type of solid woven conveyor belt belting is used in the mining industry. Nowadays when it is the belt width is a 200 millimeter, 2400 millimeter we do not use this type of fabric belt you can go for the steel cord belt those are coming.

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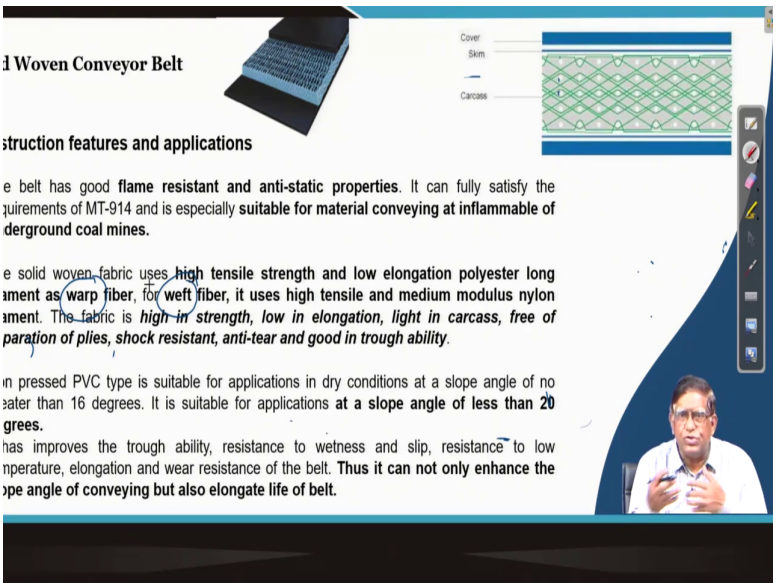

Now, there is a solid woven this type of your belt you can see here that is the press within this PVC layer there is a carcass layer where there is a the horizontal member and the vertical member. That horizontal member which is you can see here this is your longitudinal member and there is a vertical member which are called your warp and then weft. These two they are just exactly weaving solidly to get the your strong conveyor belt which is to be used.

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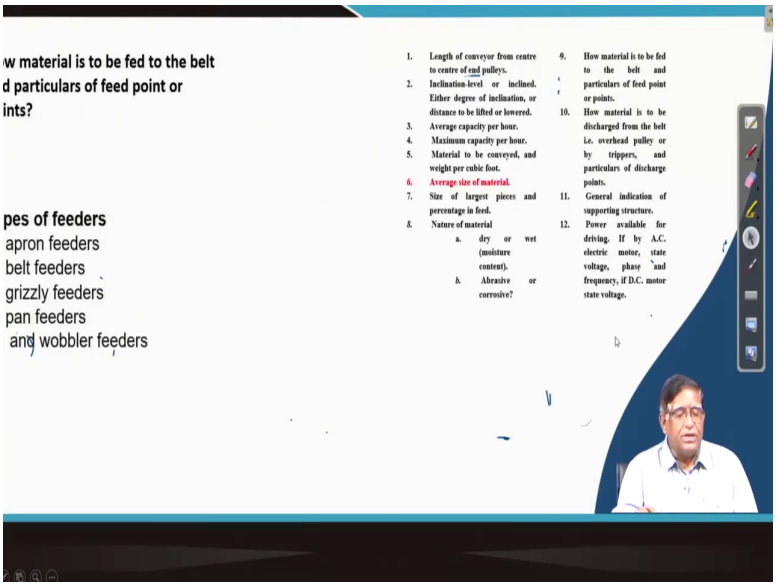

Now, this is the other criteria that is your what type of your this feeders that is how the material will be brought to your conveyor belt.

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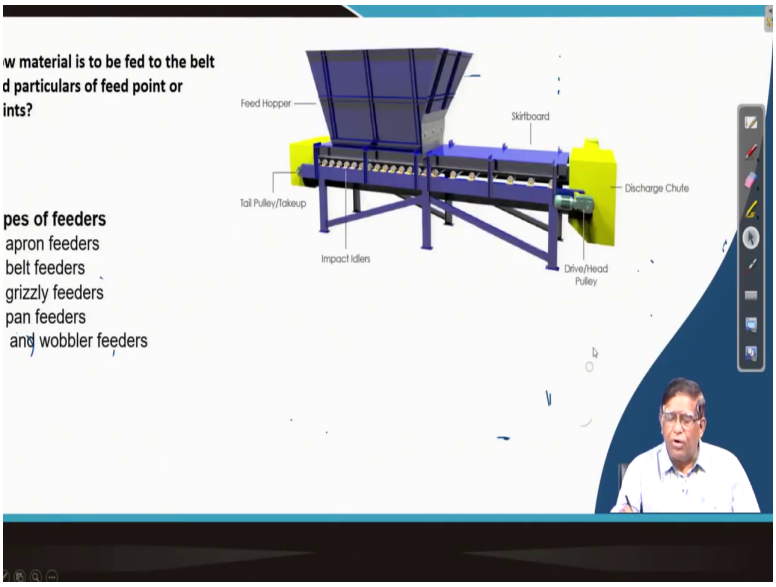

Now, the feeders can be of different type there are apron feeder, belt feeder, grizzly feeder, pan feeder and the wobble feeder. Now, the while designing the conveyor belt depending on type of material on all you what type of feeding system will be there.

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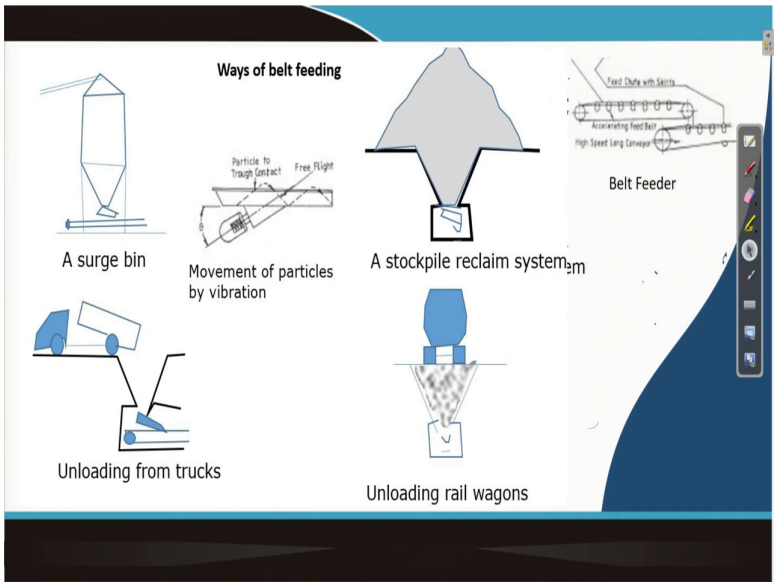

Now, the feeding can be in a different way. You can have a surge bin; that means, here we are having this the silo and from there below you are having a feeder bin and in that this is giving to this conveyor belt. Similarly, there could be a bunker a ground bunker that whole coal or things as ground on the ground below that there will be a reclaim systems, a feeder and below this one's a conveyor belt will be there on which the material will be falling.

Similarly, sometimes it is coming from a truck and then they are feeding to a grizzly hopper then it can come directly to the conveyor belt. Here in that grizzly there could be holes on the or the side bars which it will be coming. The undersize they will be going to another conveyor and that oversize which will be coming to going to another conveyor. Like that you can distribute the sizes also by a grizzly type of feeder.

And, then sometimes the rail wagons also can give it to a feeder like that and from the railway wagon bottom discharge they can give it to over here. There could be a different type of arrangements alternative arrangements for how the feeding can be done. Then the feeding also can be by particle vibration that is a you can give a vibrator here. So, that a vibratory feeder it will be feeding like that and then the material will be jumping and then it will be going over here.

Similarly, a belt feeder here the material is given to another conveyor belt and this is a slow running it will be just making the this conveyor belt will be the material will be given a accelerated before it is loading to the main conveyor belt.

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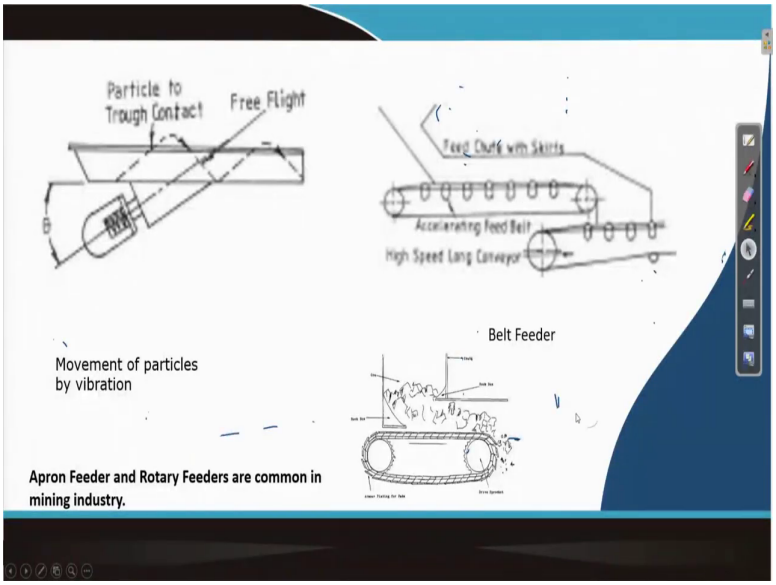

So, like that you can have a different type of feeding system. So, now, coming to this there is the feeder that is called apron feeder in which we have got a metal plate on which this material is coming and then we can do the feeding through the apron feeder.

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So, like that then there are also a system of your how that will be discharge from the conveyor belt.

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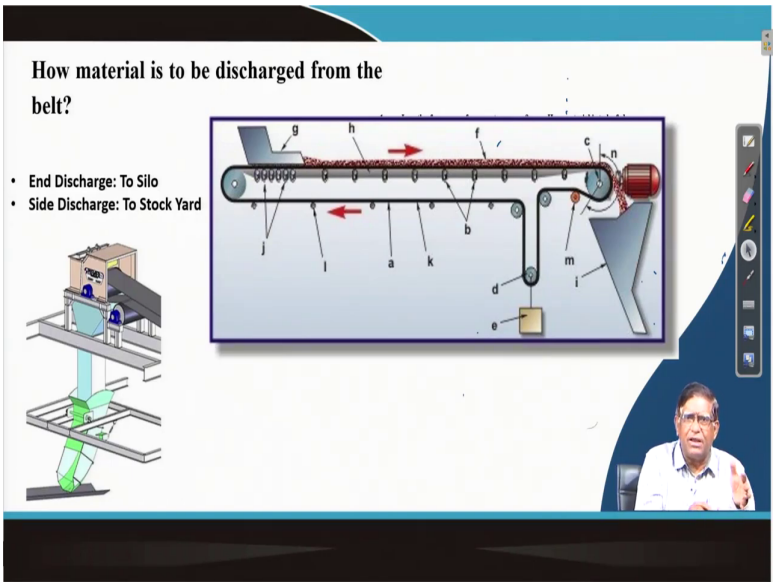

The discharging from the conveyor belt is also a another device you can see here that is the material is loaded over here and then it is coming and then it is loaded onto a that is your hopper or a bin and through that it is going. So, sometimes this this is the martin and martin has designed a very nice martin engineering corporations, their chute, they are giving that conveyor belt over here that is a this conveyor belt is bringing the material through the hopper it is giving to a chute.

This exactly accelerate the material and then bring it to the speed of this material and also this in the direction that is the direction and velocity of the particle here is a matching with this conveyor belt. By this system they exactly reduce lot of other operational problem.

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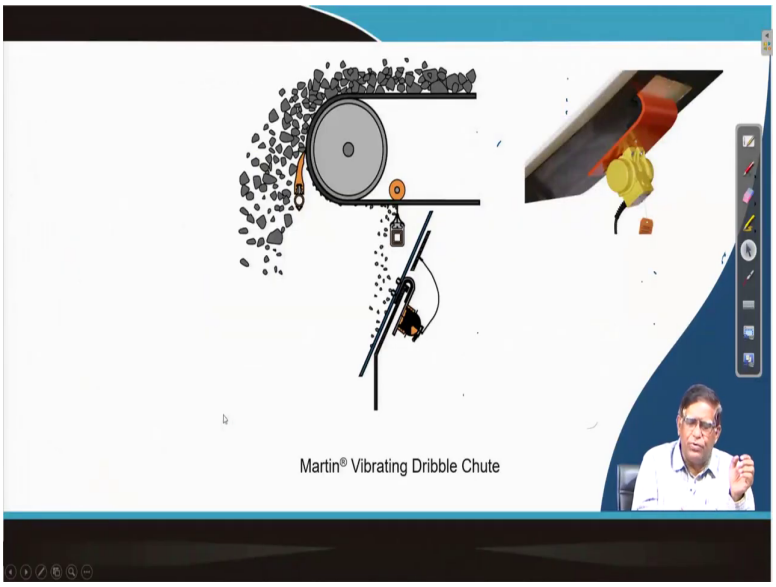

Exactly this is a you are advised I think in the reference I have given some of the references of different type of practical problems which come, your innovations and designs will be coming when you know what are the practical problems. So, you can do that.

And, this is also how exactly sometimes that material gets sticky over here. So, they have used a that is a this martin company they have made a vibrating dribble chute. So, they put it over there and then a chute is given, you get it over there.

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Similarly, that another design element is the supporting structure. The supporting structures can be mounted on and then you are having a this is a MS structure on which the whole components are placed. You can see here that is a conveyor supporting structures have got the support for the idlers and then at the end pulleys and these frames are put. Now, when they will have to be aligned, the alignment of these frames will have to be properly seen.

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So, then there could be supporting structures for an inclined conveyor belt like that or a supporting structures of a conveyor belt as you can see over here. Now, one thing is there that here everything depends on how exactly the location is there and how you can dream anything.

As I said that the engineer role is to imagine what type of solution and how you want to do it, and sometimes depending on your money how much exactly you want to spend on it. And how much return on investment you want to get it, depending on that you can design and the engineers are ready to do whatever way you want.

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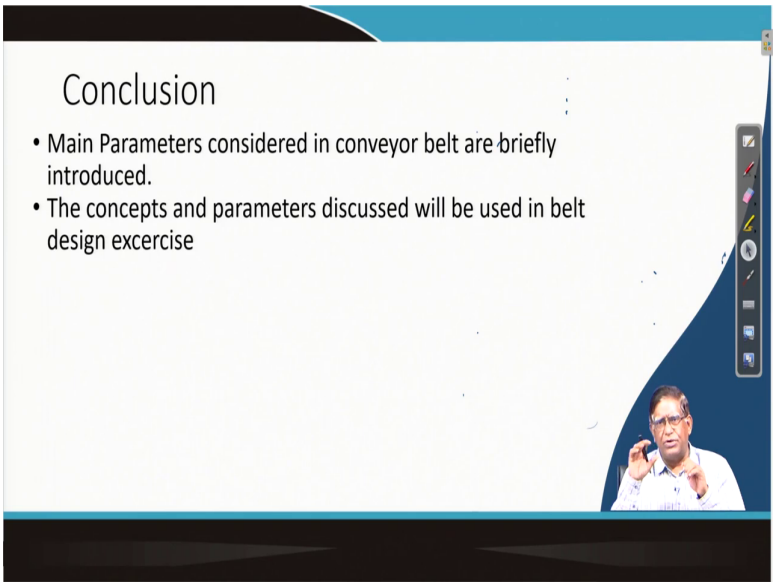

So, today we have given you some of the main parameters that are considered in a conveyor belt design and we have very briefly introduced number of parameters. Now, we need to do the calculation of the how to derive that a that how to design the drive form system. The drive system will be discussed in our next class. So, whatever the concept given today will be used.

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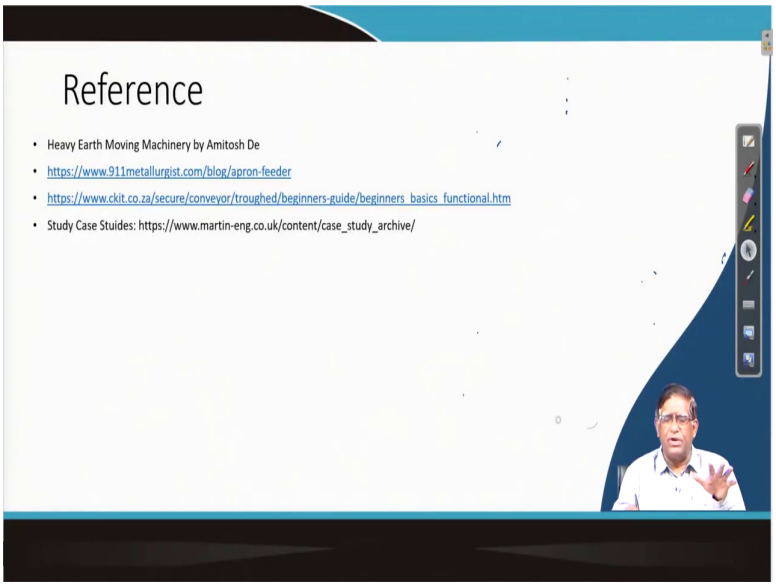

I request you to kindly go through this different these references, so that you can do and study the case studies which are given in this website. This will help you in understanding the conveyor belt, so that you can apply and do some numericals and learning exercise with this.

Thank you very much.