Bulk Material Transport and Handing System
Prof. Khanindra Pathak
Department of Mining Engineering
Indian Institute of Technology – Kharagpur

Lecture - 09
Feeding and Discharging Device

Welcome to today's discussions we are going to discuss today about feeding and discharging devices that are used in bulk material handling. As you know in bulk material handling we are storing bulk material, we are transporting bulk material, we are transferring bulk material we are processing bulk material in all those you often need to feed or load this bulk material from the storage system to the transfers system or through the transport system or through the one storage to another storage.

So, in that we require some devices these devices are called your feeding devices. And when from one storage system or from a transport system we take out the material that is the discharging system.

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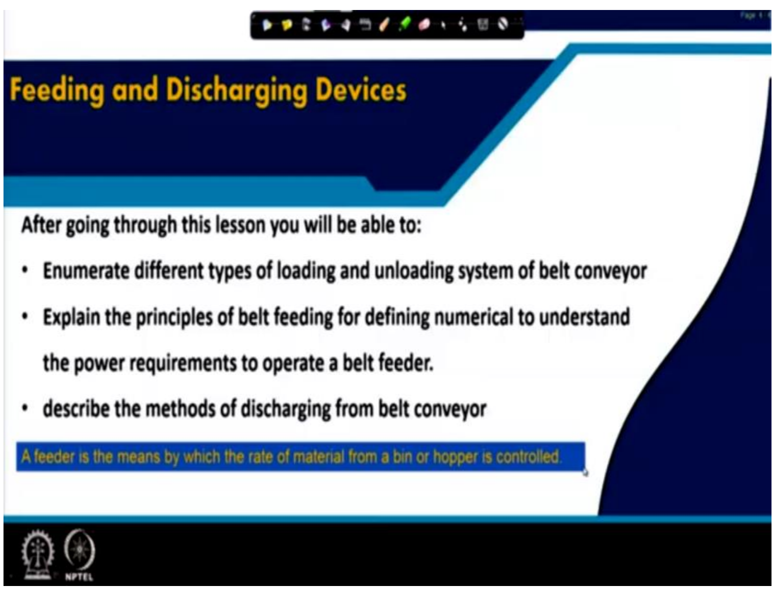

So, in our today's discussion we will be discussing about different types of loading and unloading systems for from belt conveyor as well as from different storage systems. And in that you would like to briefly discuss some of the principles that are associated with this belt feeding system. So that such feeder how much motor power it will require how will, you select them that you can decide upon for that we will be introducing this subject.

And also we will be bringing in number of different type of discharging systems very briefly. So, by feeder we mean that way your rate of material from a bin to the hopper is controlled that is we want to load the material not just the evicting a flat that all things come out together but we will be controlling it.

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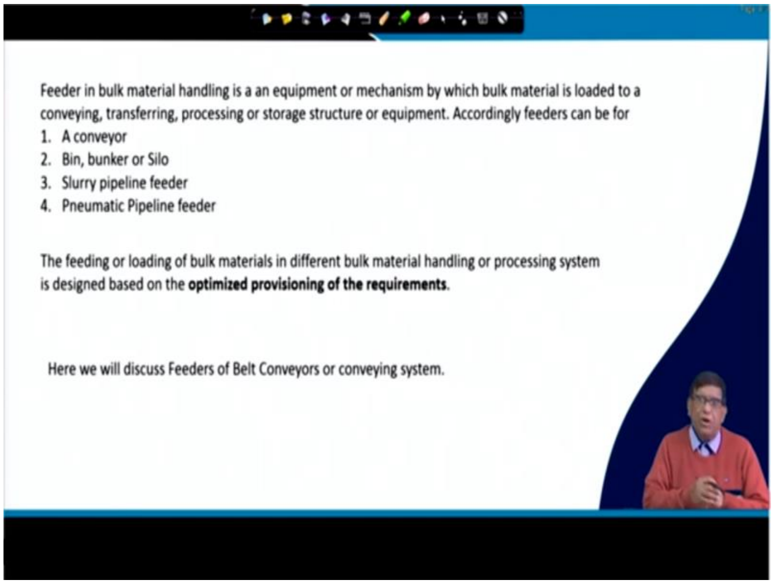

And that is where how the feeders will be working and there could be a different applications in which we will have to load the system in slurry system, in pneumatic system, the feeding will be different then from a belt conveyor system or a chain conveyor system or you are having sometimes this transportation that is your when you are even feeding of a dumper that is also how you load on a dumper bulk material from a machine that is also different aspects of it. But however main objective is to optimize this provisioning of the requirements in the processing plants or in the handling plants.

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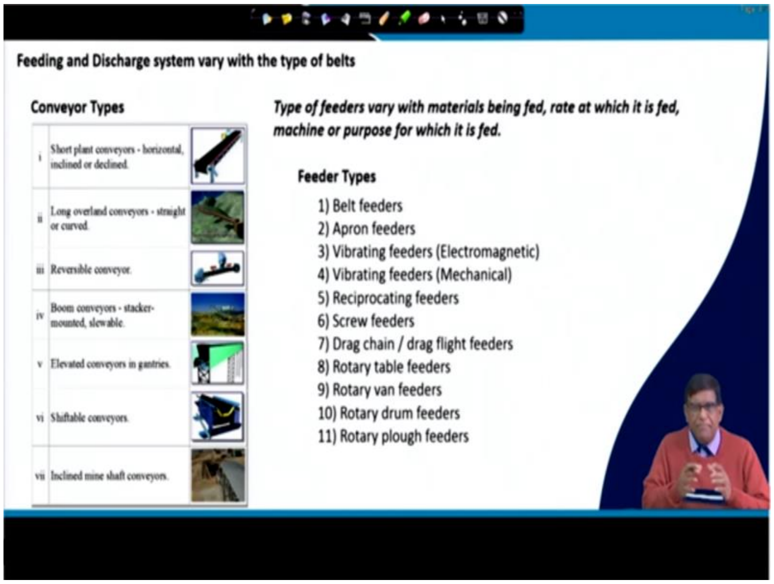

So, we will be basically discussing here, belt conveyors conveying system. In the belt conveyor types we have already discussed that we have got a number of different type of belt conveyor. Now each type of belt conveyor has got each own way of feeding the system. There are many types you can keep this in your mind that the belt feeders, belt can be filled by belt feeders can be by apron feeder by vibrating feeder which can be electromagnetically operated or which can be mechanically purely mechanically operated there could be a reciprocating feeder.

Now these different feeders could be even a powered feeder or it is without any having any power that also is possible then you have got a screw feeders then drag chain we are just having a chain over there and that will exactly giving a force controlling force on it and then that is a lost in feeders in many of the processing plan, testing plan. You will see that type of chain feeders there are rotary table feeders which are not only in the conveyor belt sometimes in the machines also.

While say for example we were doing a bucket wheel excavator in the bucket wheel excavator after excavating when the material will have to be loaded to a conveyor belt it will be going through a rotary feeder. Now there could be rotary feeder of different type they could be a one for van type, there could be a drum type, there could be a plough type different types of feeders are there and then many innovative designs they were made.

And in the future again maybe some of you will be designing a new type of feeder only for going to things for reducing it stoppages for maintenance for optimizing energy, for improving the flow rate those are the factors on which the designs are made.

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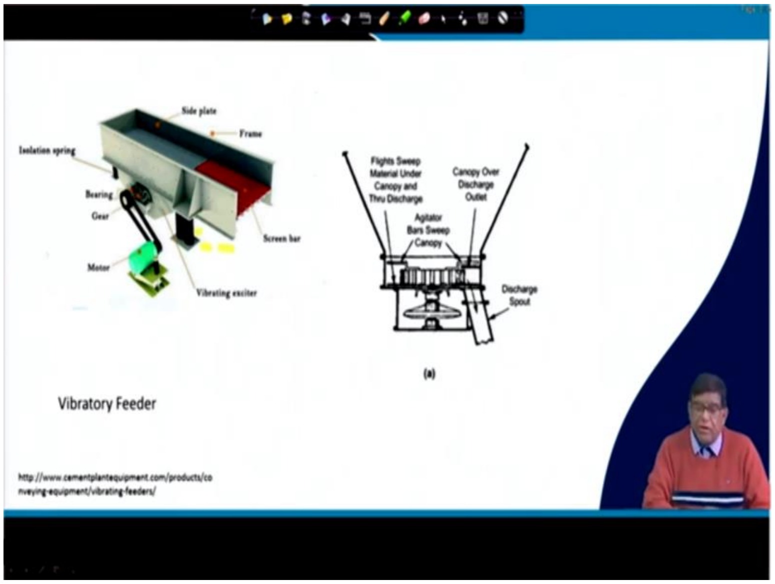

So, you can see here one particular feeder that is called your vibratory feeder. Vibratory feeder is nothing but just like in your chef at a home we do this exactly when we take out in a rice that is you want to remove that rice where there is no the grains inside. So, those things that the waste part to be separated out you might have seen the chef that they give a flattering by hand and your material goes out.

It is exactly giving the vibrations the lighter particles get jumping and then they are going out. So that principle is used in this type of vibratory feeder where that electric power is given over there to buy you make an engineering way how by giving an eccentric shaft or by distributed mass so that whenever this is that your conveyor belt is that belt drive is rotating that lower band of the feeder will start vibrating.

And the material will be jumping over there and going forward I am getting a motion because of the slant which is given over there the slant only maintain this things are how exactly you will be working over that angle, this angle will be giving you the this angle which you are maintaining over here this angle only gives you this how it will be going towards. Similarly we have got the different other types of feeders are also there.

That is you can see here this is one another type of feeder in which that the discharge spout is getting opened and closed by a bar which will be sweeping out. So, this can be loading to the below here this point there could be your conveyor belt could be there that conveyor belt will be getting loaded by this.

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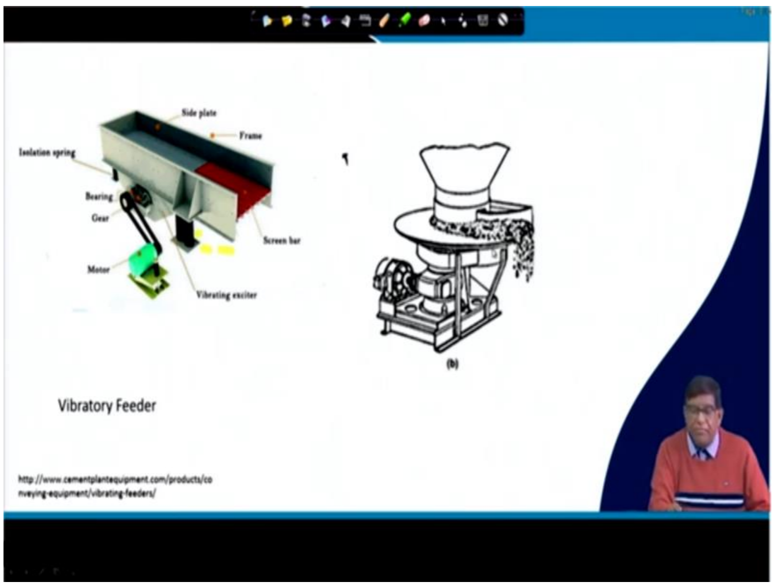

Similarly you can have this type of rotary feeder that is below this bin the material is when this table is revolving at the time material is taken out and then putting it out so that it can be loaded to another conveyor belt.

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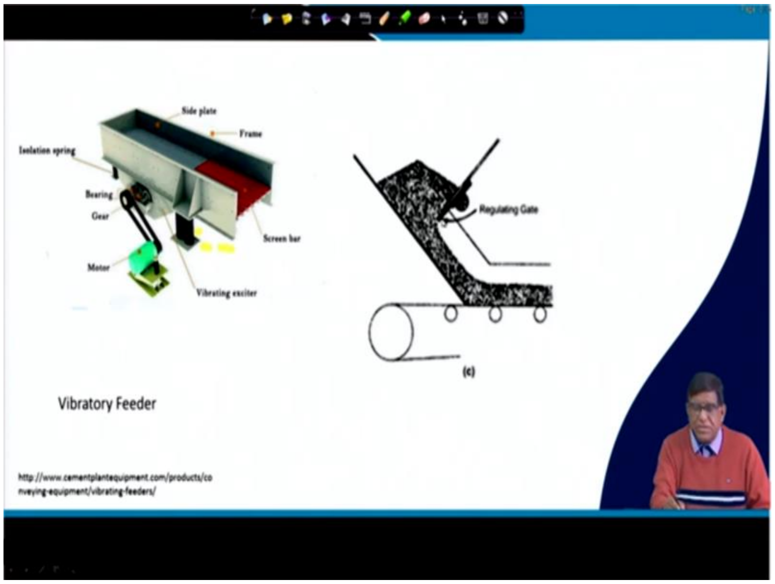

Similarly if you are having a this your hopper, from the hopper you are bringing the things to a skirt board of a conveyor belt by controlling a gate you can just make that how much material will be fed or loaded into the this conveyor belt.

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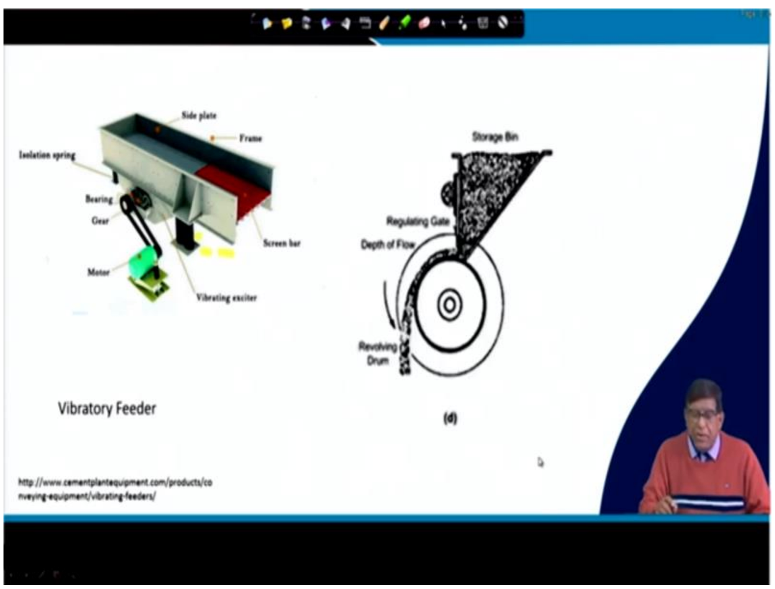

Similarly you are having sometimes from the storage bin you can bring the material by this roller when this roller will be rotating that will exactly make this material will be taken out from the bin and it will be loaded to the next one.

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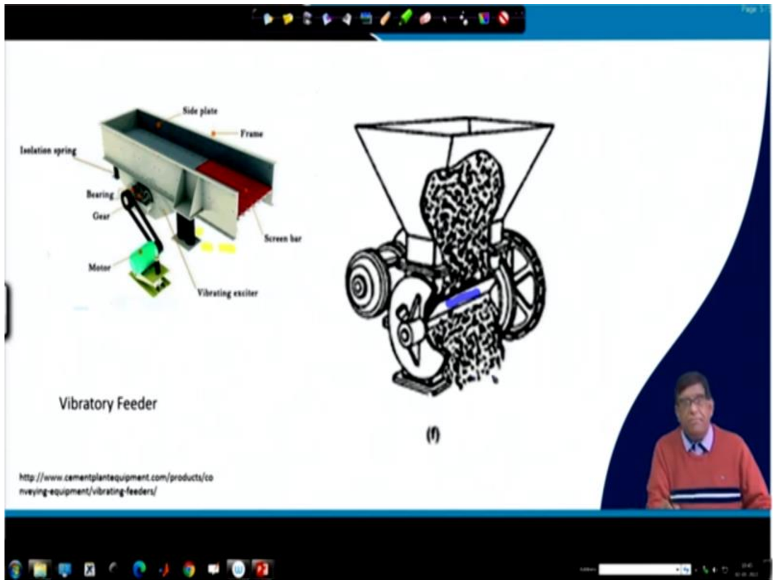

So, similarly you have got sometimes a feeder in which you can see that this is rotating and this particular plate is working as a this plate here it will be working as the gate. Now when this will be rotating at that time this material will be going out and then this can be at a control manner loaded to another these devices.

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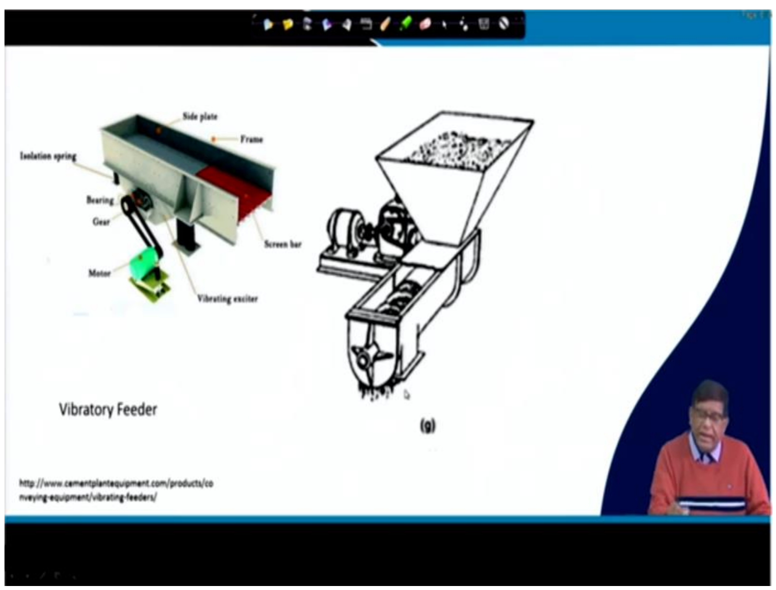

Similarly when we see here you are having a screw type of conveyor below this hopper. So, now when this screw will be rotating it will be taking up the material from there and it will be loading at this lower point. So that it will be feeding if you are to give it to a processor or play another transferring system.

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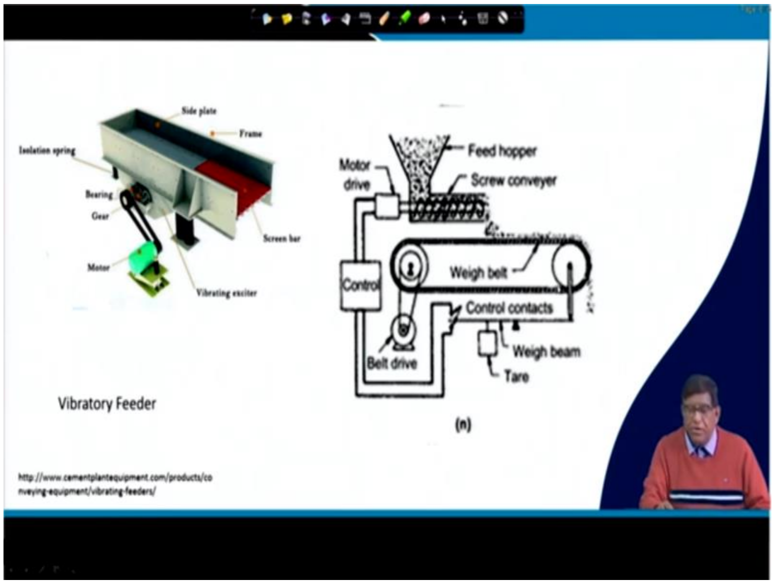

You can see here how the screw feeder is working on to loading onto this conveyor belt where the material is also it can be weighed here that you are the weighing system is being fitted over here how much material has come that weight, if the weight is coming say you are giving more loading is coming for the next process then what will happen this controller will do this control the speed of the screw conveyor so that only the required quantity will go.

So that is having a closed loop control system you can exactly give the required amount of material say for example in some of the processing plant when 2, 3 different types of materials are coming at the proper proportion. So that type of system can be controlled automatically by this type of arrangement.

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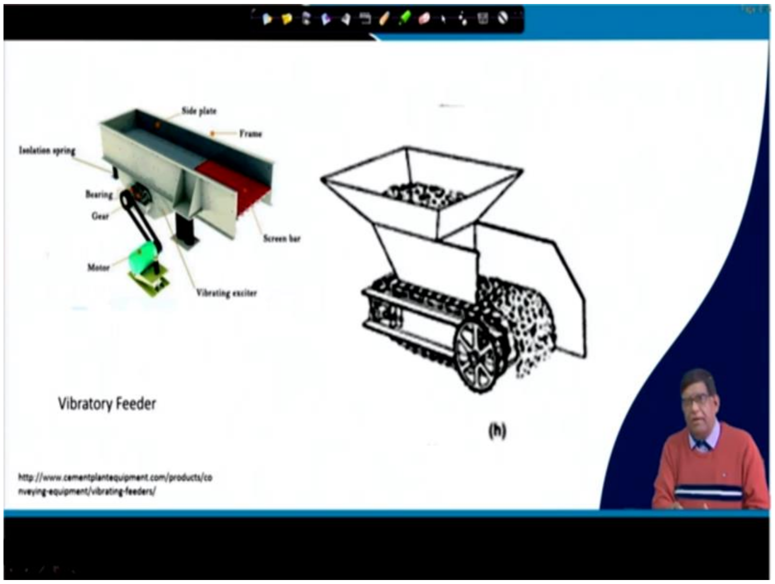

Then there is this type of feeder which is a belt feeder you can say that is from the hopper it is coming and falling onto the belt. This belt can be a ordinary your conveyor belt or can be an apron that is in case it will be an apron feeder or a belt feeder.

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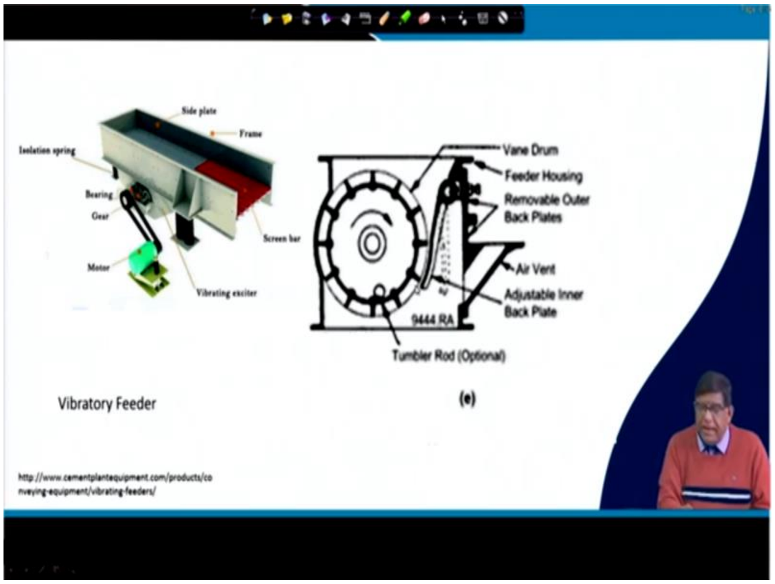

Now this is having a tumbler with the rods coming over here when it will be rotating it will be giving it this adjustable inner back plate is there this will be allowing the material to come from that hopper to go.

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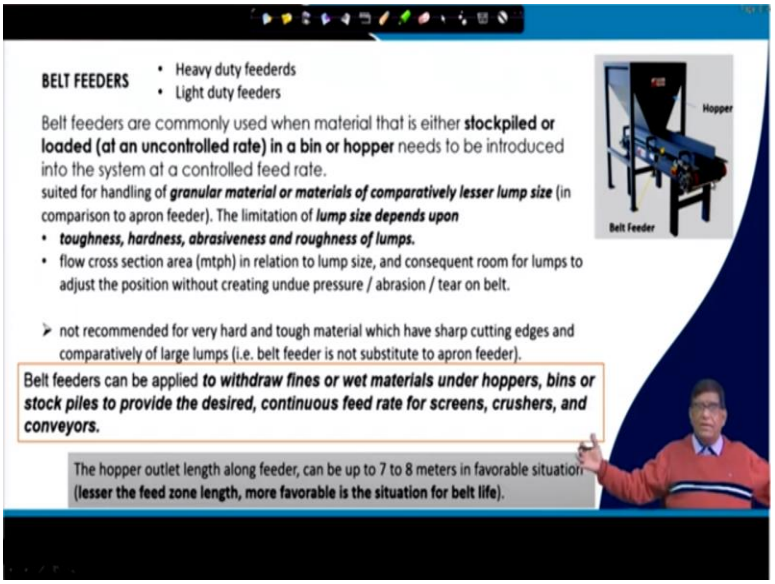

So, then you have now seen that there are quite a wide range of feeders are available out of which belt feeder is one of the very common type as you can see there is a hopper and the conveyor belt. The belt will be having its drive this is a very simple system but when you were using this in a very heavy duty say in a coal handling plant or an iron ore beneficiation plant there will have to be designed according to the requirement.

So that can be, there are many types of this belt feeder could be there, now they are most commonly used with the granular materials and then the material property that will have to be looked into properly while selecting a particular feeder. Now these a first thing is you need to know about the lump size, if the lump size is very big then from your hopper to come out to the conveyor belt they will get obstructed then the flow will be restricted.

So, this is only for the granular or will fragmented material then designing the gate properly it can be used. Now the other properties like the toughness, hardness and aggressiveness are also very important to see over there. Now they how the material will be taken out is a very, very important thing and there that is you need to know about how bulk material when you are storing over a bin and how it will be flowing that needs to be known.

But at the same time there is another very important problem that is the abrasiveness, if the material is really highly abrasive you are using a belt the belt may get cut. So, in that case for a very hard and abrasive material you will not be using a rubber belt, you may be using metal plate or you will be using a apron type of feeders. Now this is sometimes if you are having your very wet material.

And then may if you want to that your for putting it to your screens or crushers in a processing plant you need to consider that how it is a sticky material there cannot be fed like that. So that is wherever you are flowable that is your little bit near to the homogeneous mix of material they can be used over here. Now the distance from the hopper to the endpoint what will be the distance that will have to be also decided carefully at what speed it will be coming that will have to be decided carefully.

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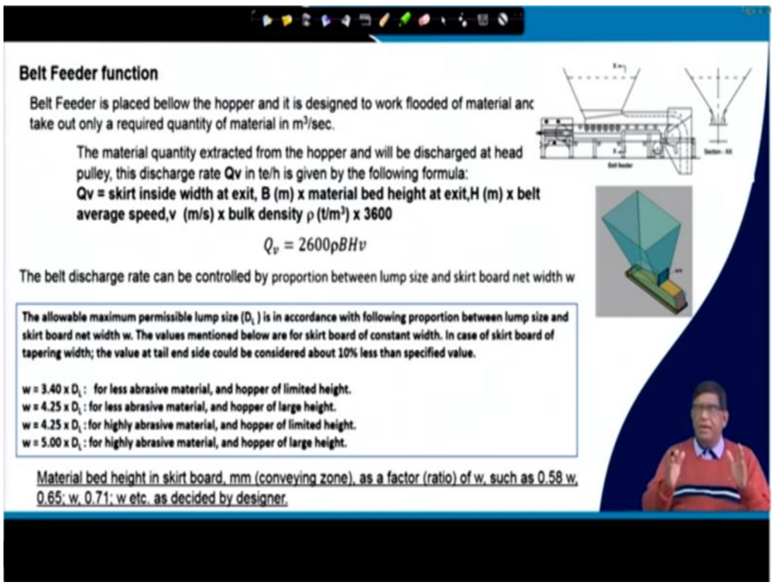

And you can see here that is if you are having a hopper and then you can see that this belt is there. So, there will be a gate, so now that designing that gate designing this angle at which this that it is meeting with the belt and then how much exactly the material will be containing all that point will have to be disturbed considered in designing a hopper belt feeder. Now you can see that this diagram it is showing you that is in your which way exactly you are having the material is flowing from this zone.

Now when this material is flowing over there you can see that your material flow from this point when it is going then you are exactly in the front part of it you can see here that is your material is stored on this angle is very important by which the material will be flowing down like this. And then in the front you can see here this particular zone which is having this is your gate part. Now they are loading and this whole thing is sitting over this conveyor belt.

You can see here the conveyor belt is here you are having those impact idlers so that the material which is giving any load it will be not making the belt to set. Now what is happening over here they how much quantity will be extracted from there it depends on exactly that what is the width of this skirt board here, this lower portions these width exactly will be determining how much material will be going.

And then what is the height of the material on this exactly there is a; this material how much height it has been allowed because that will be depending on the dimension of the gate. The material will be coming over here. And then the belt is driven at what speed and from there you can easily calculate if you know the density that is in turn per meter cube then how much turn per that is your turn per minute or turn per second or turn per hour you can calculate this will be 36.

So, then you can find out that how much quantity will go. So, similarly when this discharge you will have to control on this skirt board then your total weight is very, very important. Now this width of the material and that lump that is as I said the bigger lump if it comes then you are from the gate it will not come out. So that is why for different type of material you will have to have the width of that opening depending on the lump size.

So, this is in some cases your width should be about more than 5 times that your size of the lump particularly if the material is abrasive material and then there is a hopper is having a very large height in that case you will have to have a wider one but for less abrasive material and then a limited height hopper you can have up to 3.4 times. So that means the width of that gap it is depending on the maximum lump size that maximum lamp size is again you know that if any lamp is here the maximum size will be measured by the longest distance of it.

So, this D L if it is known from there exactly you can calculate what will be that your skirt board height as well as this your; the ratio that this skirt board height and if you know the width that their ratio is also it can be found out from different design these are experimentally in the laboratory a skilled experiments are carried out and from there exactly in the plant the design is done.

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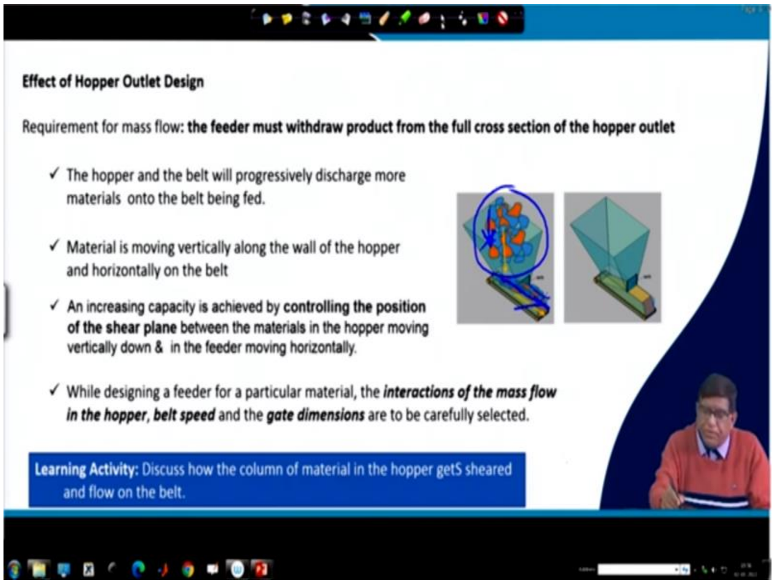

So, now one most important thing in that how that outlet will be designed this will be depending on how material will be withdrawn. Now the material withdrawal is again a phenomena that is exactly you are having a stack or that you have got in a bin this material as you can see over here that your materials are stacked over here. Now this material will have to flow down like this and then in the conveyor the material will be going like this.

So that means a vertical movement as a horizontal movement, now sometimes when initially there are no movement over here then when the conveyor belt starts moving that lower portion material starts moving this direction. At that time there will be a shear taking place. Now where that shear plane will be there and how the shearing will take place that will determine whether the material will be flowing properly or not.

Now when you are designing this that these interactions of the mass flow in the hopper that will have to be considered and this is whole thing will be controlled by the belt speed and the gate dimension. The gate dimensions will give that how much what will be the thickness or height of material that will be coming out. So, now for that purpose you can see here.

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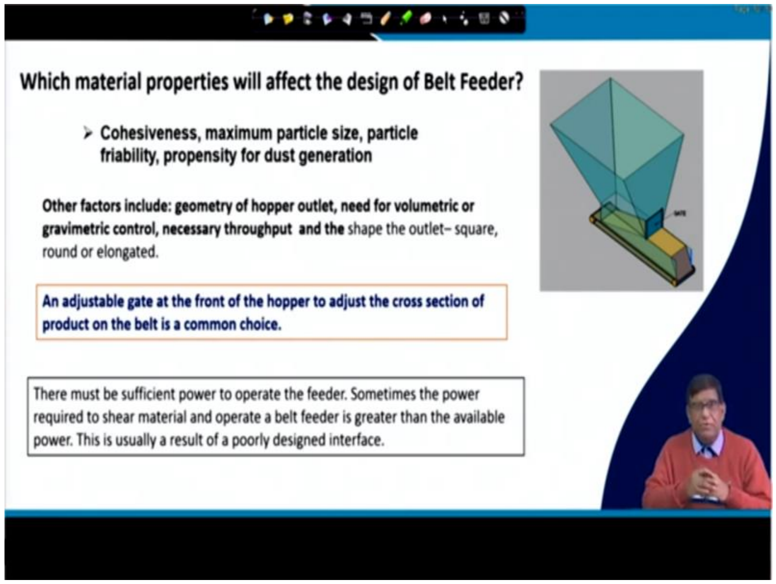

Then your which material properties will affect the design of the belt feeder by now I think you can answer this question that you are you will have to consider abrasiveness, lumpiness that your cohesiveness, your the maximum particle size, the friability, their different propensity for the dust generation. One of the most important area in bulk material handling is maintaining the atmosphere with so that your pollution does not spread you must not emit for that again different aspects of considerations will have to be taken and the protective devices will have to be made.

So, now the material properties will have to be compatible with the design criteria. And that is what exactly you will have to make it and sometimes this whole thing for your control purposes will have to have a adjustable gate that is the gate which will be in the front we will have to make it adjustable depending on that is your if the material coming with a property may vary during the rainy season you may get material with higher moisture content during the dry season you may get the material with less moisture content with the moisture content.

Therefore flow ability will be different and that time your feeder how will be working will have to be taken care of so, now for this reason that is you will have to control the quantity you will have to depending on the property change you are the resistances may be different. So, you will have to very carefully select the power required to that is your shear that material for making the flow so that the feeding can be done.

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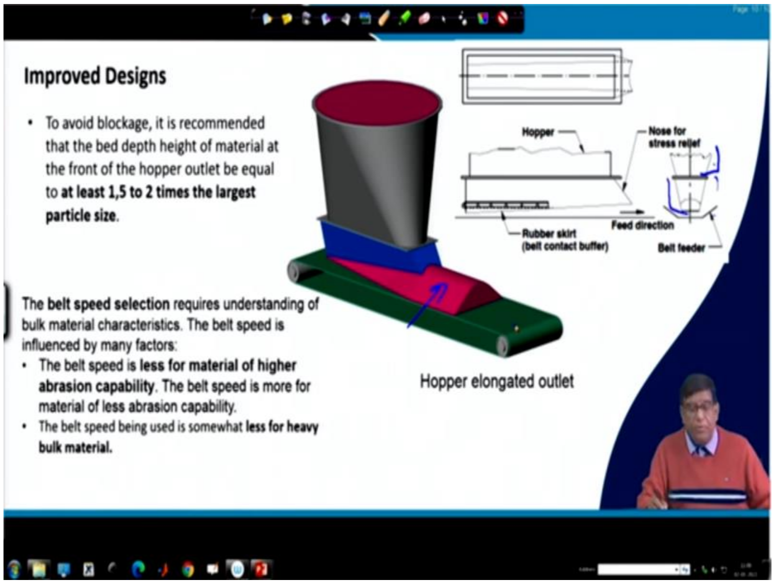

And for that there is your objective is while you are feeding at the time material is not getting blocked if the material get blocked that means how much even if you want to give a more power if your motor is not properly designed your motor will get burnt. So, you will have to consider in the belt speed selection if your belt speed if you select if the material abrasion is very highly abrasive material then you will have to make a less belt speed.

And then if you are material is your very heavy at that time also you will have to use less belt speed. Now sometimes you can have a design can get changed as for example there is a elongated outlet what is happening here? You can see that at the top portions there was one hopper and then this you can see here that this portion there is another portion is coming over here.

This another portion so that well it is feeding over here there is a belt feeder will be coming over there by this you are accommodating more material and the more material can come over here. So, by that separate designs have come which is exactly give you the type of a design of a new type of hopper.

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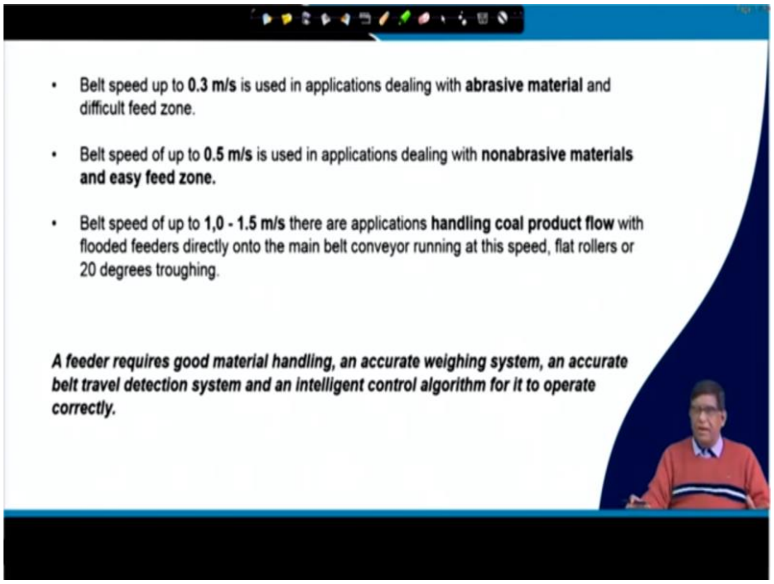

That can that give you increased the flow rate and as well as it can handle different properties of material. Now this material speeds while feeding is normally it is less your 0.3 meter per second because there can be number of feeding points and then they say depending on how many feeding points are there and what is the total capacity of the belt conveyor which is taking this load from. Now by comparing and unleashes you are so that the overall mass flow rate.

Because at the end of that your main conveyor belt which is designed for a particular capacity that capacity flow rate will have to be maintained. For that purpose each of the individual feeder that will have to be designed and accordingly to be put. So, these types of problems are handled very effectively only when you are designing with a real life problem. Now you need to see that the belt speed up to 0.3 meter per second is used in abrasive materials.

And then they were the feeding is having even a difficult feed zone because this abrasive material they can make that is your damage your conveyor belt up to 0.5 meter per second that much you are increasing the speed when you are handling that is your non abrasive materials. So that you are feeding zone is now easy. Now it can be 1 to 1.5 materials so for example in case of coal say it is not very highly abrasive.

And there we can go up to 1.5 meter and then a feeder always require a good material handling and accurate weighing system that is so you must know how much exactly you were feeding or how much exactly you are loading onto the belt and accurate belt travel detection system that is weighted the what is the belt speed. And then an intelligent control algorithm that means the wherever you go to see any coal handling plant look at that how they are being controlled. If they do not have a proper belt travel monitoring system and intelligent control algorithm it is quite possible that they are exactly using more energy.

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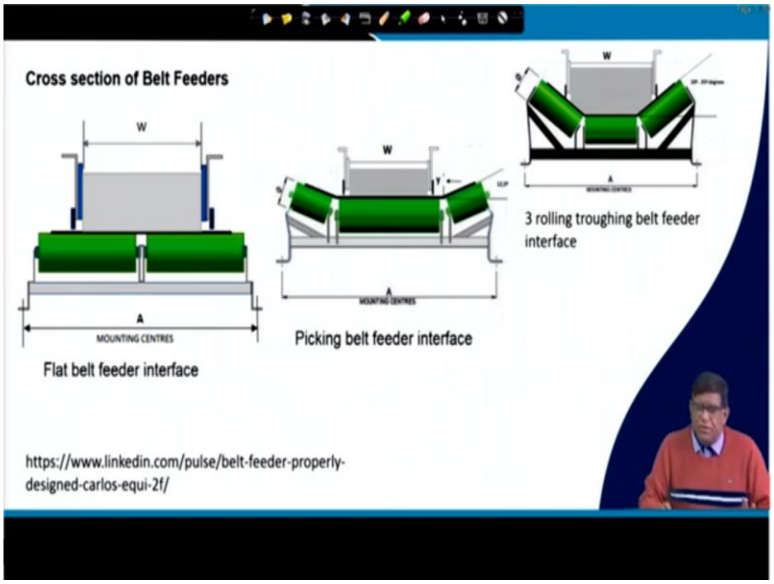

So, similarly we have got different type of cross sections of belt feeders could be there you can see that belt feeder could be flat, it could be with different type of idler system.

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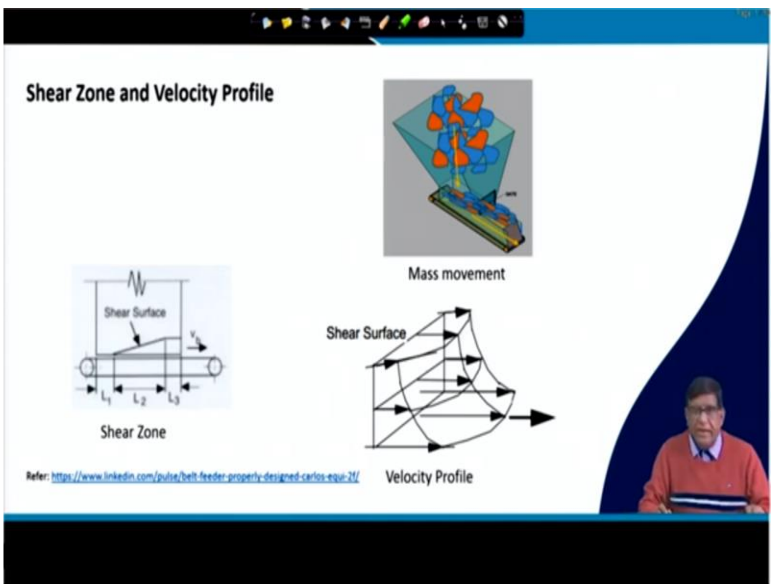

Then there could be the shear zone bear velocity profile this is very important for knowing that is exactly where the material is getting shear that you are vertical movement and the horizontal movement.

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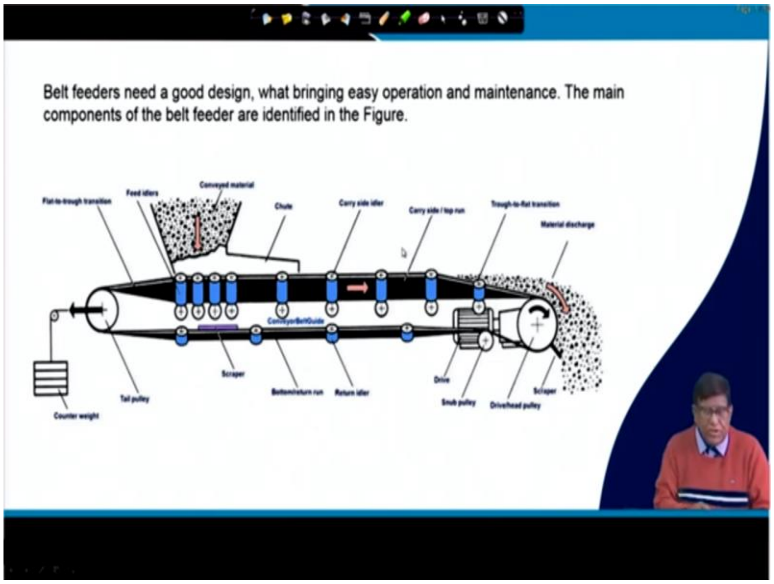

And this needs to be analyzed when a feeder will be coming. So, this material flow overall system needs to be controlled.

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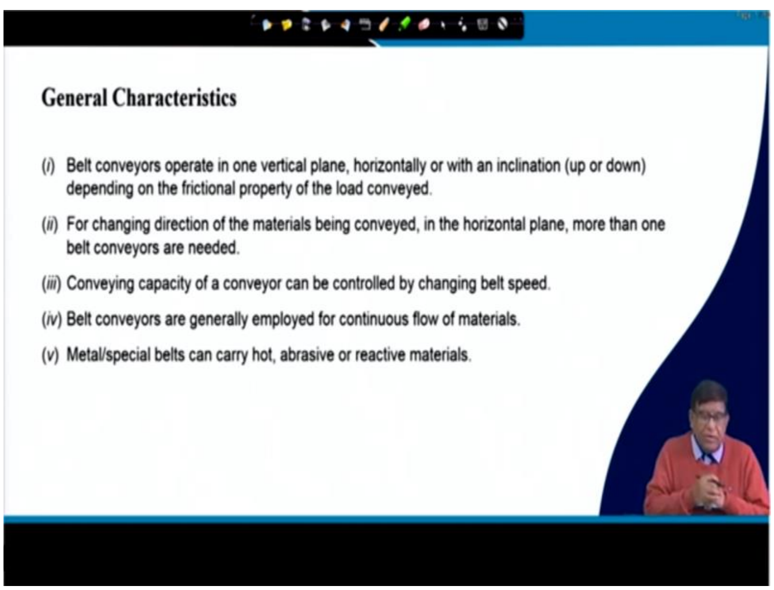

So, in a belt feeder when we are to get these things, this is having the general characteristic that is that controllable, it will be operating in one vertical plane horizontally with an inclination is there. So, your material can be lifted even in your for here that lower portions this material has gone over here and it is going up to slight lifting of the material is also taking place.

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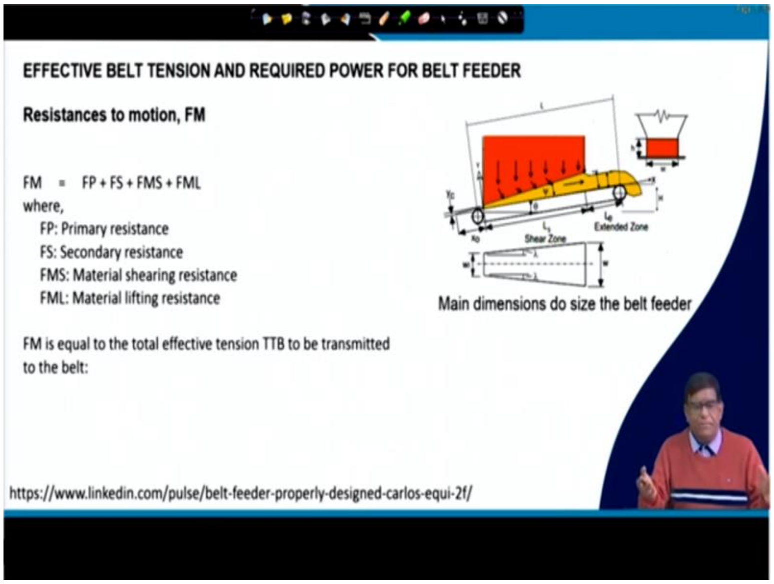

So that is when you see over there that how you calculate the motor power it will require say, if you see that there is a that you are vertically the material is falling like this and then material is carried out over here. So, this material from here it is exactly raised up to this level. So, what dimensions you can see over here, this is you are the belt conveyor belt feeders and to and pulley dimensions you can see this is the opening dimensions this is the angle of inclination by which it is getting lifted.

Now here is the shear zone this material is getting sheared here and then the flow and then this person is the extended zone. So, now that mainly the resistances has to the motion it will be coming from the 4 components that is your primary resistance, secondary resistance, material shearing resistance and the material lifting resistance. Now these resistances if you can calculate the total resistance how much Newton it is coming.

And if you know at what flow rate it is going then that if you multiply this FM by the velocity this Newton meter per second that much of what power of the conveyor belt that is your motor drive will have to be taken. Now that motor drives electro of course by depending on the efficiency of it. So, FM into V by divided by the efficiency you can find out that what will be the motor power required.

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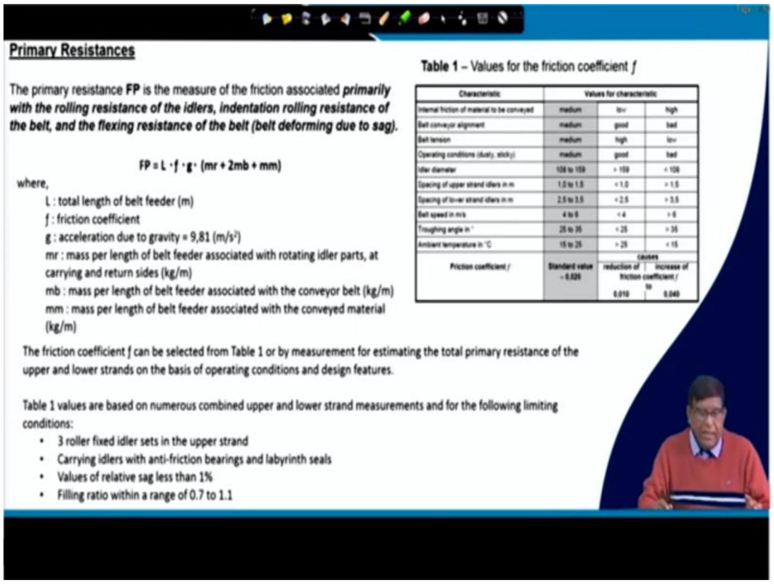

Now if you will have to calculate the primary resistances, the primary resistances will be coming depending on the length of that conveyor belt as you have seen in the figure then the friction coefficient. Now that friction coefficient you may have to calculate it from the standard books or you will have to determine over there and then the mass per unit length of the belt it is again elect to get from different manufacturer and the mass per length of the belt feeder.

This exactly the friction coefficient in some standard books are the your standard specifications you can find out if you have not calculated out but for different material you can take the standard will do a friction coefficients 0.2. And that will be 4 depending on whether you are getting the for low or high range or medium range depending on that the value can be point 0.042 or that in 0.01 that is the range of this frictional coefficient. And then you can calculate out there depending on what type of roller systems are there that you select. So, this gives you that your primary frictional resistances the values will have to be taken.

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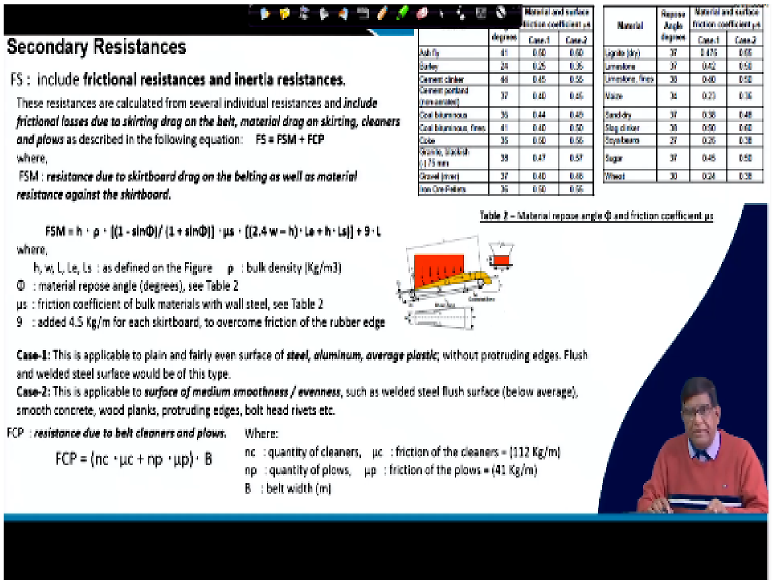

Then secondary resistances come from the inertia resistance and also due to the belt cleaner and plow which are used along with your feeder. So, here also you can find out the frictional the total resistances of the skirt board break it will be depending on that you are the material angle of repose, the angle of repose which is having relationship with the frictional angle. Now the frictional coefficient of the bulk material which has been given over here.

You can see 4 different types of materials. If you are taking say your coal bituminous coal you can find there this you are according to the repose angle you can find out that coefficient of friction is 0.44 to 0.49 you can take out from there and then angle of repose you can select and from that you can calculate out that what will be the frictional resistances. So, these are available in different handbook you can find it out.

And then for type of materials whether your belt that you are using a conveyor belt or you are using a your aluminum belt or you are using a steel belt depending on that this frictional value another value will be there you can calculate this frictional resistance. Then the belt cleaner and the plow there exactly how many number of cleaners are there or how many number of plows are there for removing and cleaning over there in the return said cleaning will be done by plow. And then you are the carrying side cleaning will be done by the cleaners and their number and their frictional resistance that we will be giving you the total amount of resistances coming.

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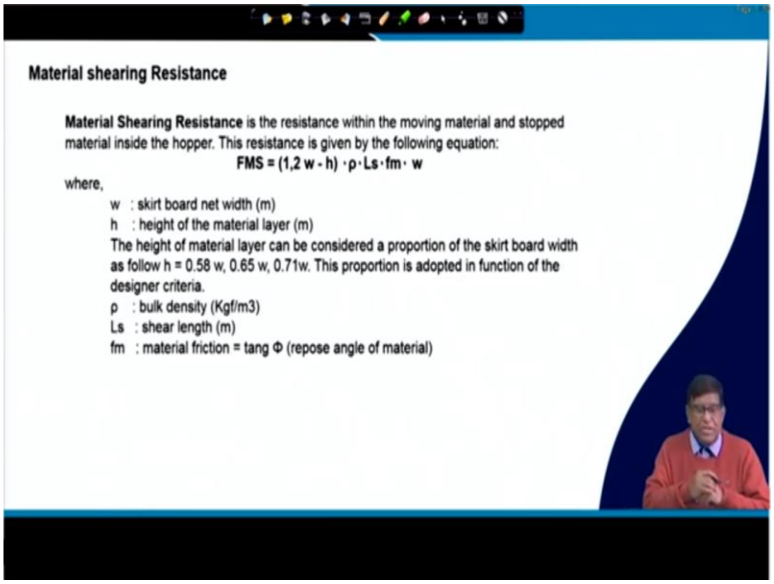

Similarly the material shearing resistances it will be depending on the skirt board net width that they have seen in the figure and then the height of the material and the bulk density of the materials. And their sheer strength of the material which is exactly experimentally iron ore mining laboratory you determine after that you can calculate out what is material shearing resistances.

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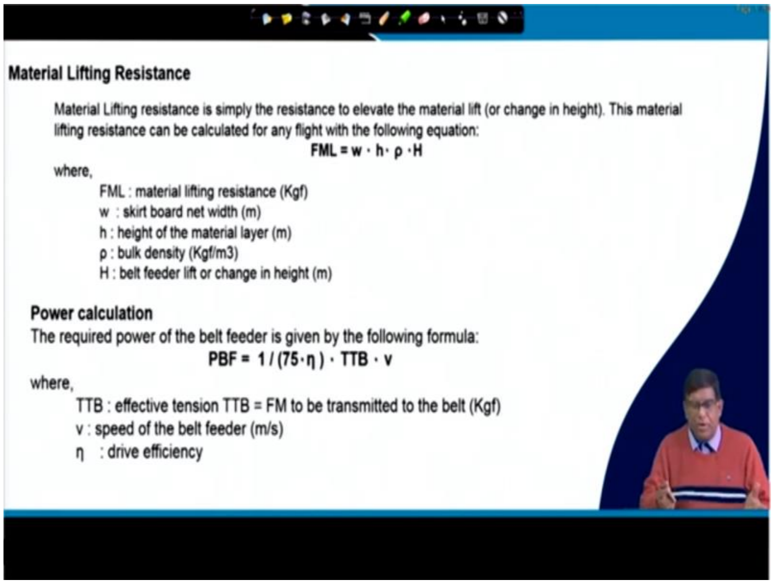

Once you know that the lifting resistances how much height it is only that and which formula is used here that is you are from that gravity how much load it is coming now once you find out you calculate that FM which is exactly that your main effective tension is the total resistance

FM. So, if you multiply that then you can write down the power required that efficiency is the motor efficiency by that you can calculate out what will be the power required for driving.

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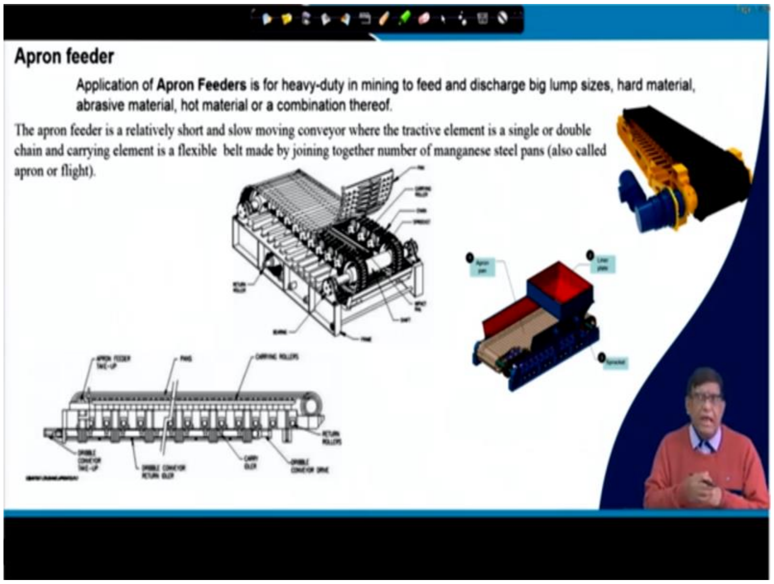

The other type of feeder which is apron feeder instead of the rubber belt, we can have a steel chain on the chain you are having a metallic plate this type of feeders are called apron feeder. Now when that a very rough highly abrasive and very hard materials are to be feed just like your iron ore if you are working in a iron ore processing plant you can find out this type of apron feeder in the plants.

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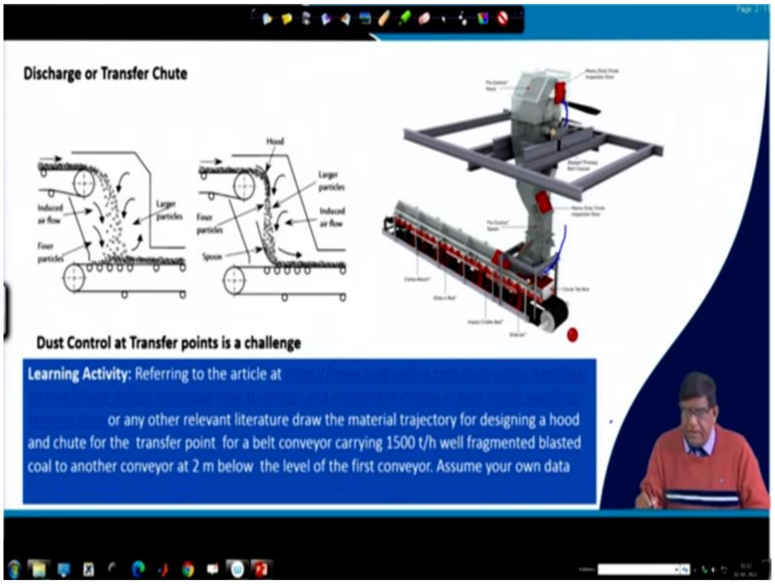

So, then you can see that discharging from the conveyor belt will be by chute, now this designing of the chute how the material will be coming what will be the projectile in the because if the velocity is more at that time you will find this velocity is having very great then this projectile will be going in a further distance. And there the different particles also will be getting that is just different sizes of particles depending on their weight we will be taking a different profile as a result you are the material can be flowing in a this much height or the material will be going within the this range.

So, depending on this you will have to do hood which will be coming over here that will have to be put that is your that hood will have to be designed and then we chute add that were from that hopper material will be coming will have to be designed. So, this is another important point over there is the dust which will be going out there how will you collect the dust from the hood that is also the in the discharge the transfer point you will have to do.

So, you are as a there are a number of articles and things are available in the net as your learning activity please take some this type of literature's draw the figure and then try to design or conceptualize that how this thing can be improved. So, the other thing is you can find out that in Martin and Martin Company they have done a lot of work on designing this chutes and then show that there will not be any blockage of the flow.

If you start studying in our Indian mineral handling and material handling business the throughput capacity is often less because the capacity utilization is often less because of the different flow problems. Now that flow problems come only because that our discharging and loading that systems are not effectively because that many of them the conveyor belt is but thing is that you cannot feed over here. The conveyor system is but you cannot take out the material properly effectively from there.

So, in these 2 points there is a necessity you can study that how Martin has developed their chute there is a very specific profile chute you can see that this conveyor belt is coming over here then the material is given and then they have used the gravity then take the second portions of the part where from that the material is giving loaded to this feeder. So, these types of systems require in our bulk material handling you can have a look of this.

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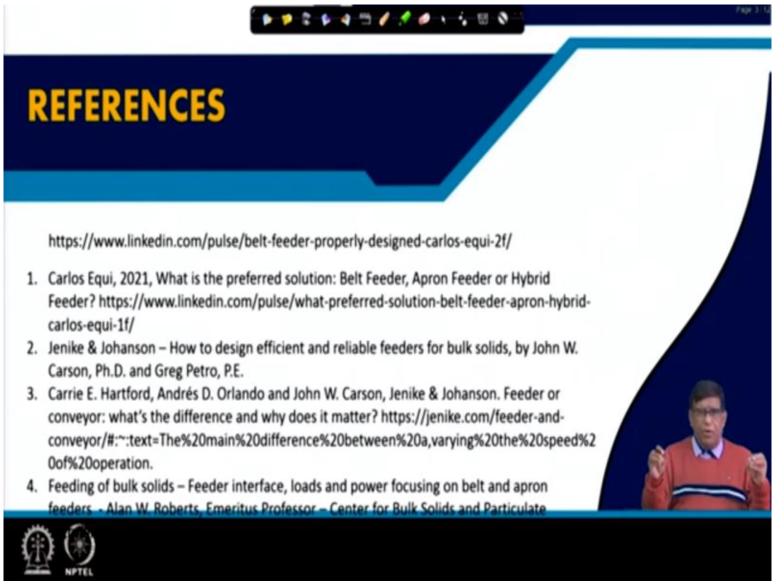

Because the detailed discussions can be obtained and can be studied separately and if time permits in some of our class we will take a simple realistic problem and solve it normally that is done in your tutorial classes.

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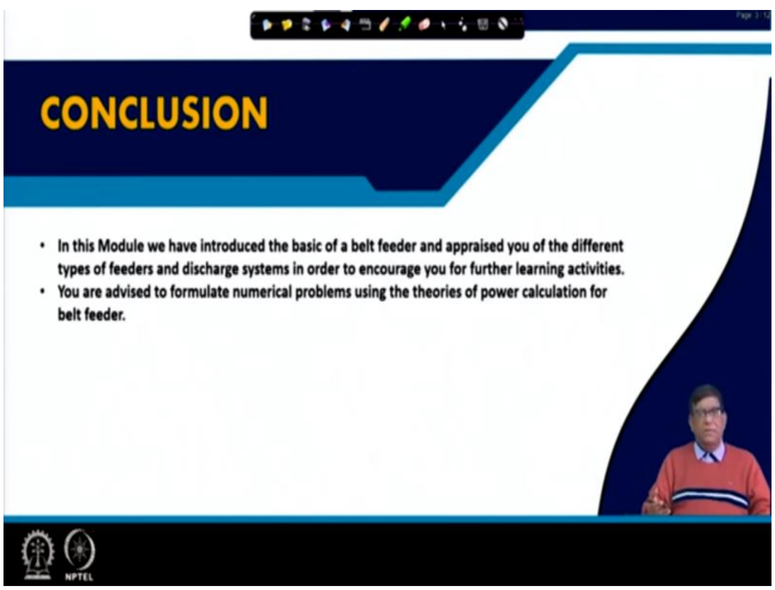

However for the time being you need to do that exactly after knowing this basics you will have to take some numerical problems very simple theory of belt fitting has been discussed over here, you can create some of the problems and see and feel how the value differs that means, if you are having the density is different than how for the driving the same devices and all that thing how much additional motor power will be required.

If you are the discharge gate width is increased by that how much exactly will be the effect on to the motor power. So, such types of simple exercise I advise that from the theory just know we have discussed you make a note of that and then it will be making some more learning activities over here. As it is known that bulk material handling and its components there is a wide range of varieties that are there.

But the basic principles if you know that is calculate what are the resistances coming in this flow then you can find out that some of those resistances will have to be overcome by the driving system and by that you can design the drive. So, why giving the drive, what type of mechanism, what type of arrangements will be giving, how will be giving from the motor whether you will be going the power through a gearbox whether going through a chain or whether going through a belt drive there can be a lot of alternatives can be available.

And on that the innovations may come and this may improve the services, improve the maintenance and improve the working and economics of the plants which are operating in India and many places. Thank you very much.