**Bulk Material Transport and Handling System**
**Prof. Khanindra Pathak**
**Department of Mining Engineering**
**Indian Institute of Technology, Kharagpur**

**Lecture - 27**
**Feeder Selection and Design Aspects**

So, you have been studying about this bulk material handling we stocked we stored in let us say your open storage school then closed storage we have talked about this bin bunker and silo. Now this one question arise we even I think in our introductory classes regarding the conveyor belt there we also discussed about some of the feeders. Now today we will be talking about feeders which are used along with the storage device.

Just in our previous class you have learned about the feeders well feeder and apron feeder. Today I will be touching upon those things as a little bit of revision of the things that what you studied about the belt feeder and apron feeder for the conveyor belt. But today we will be giving an emphasize on that how it is exactly evacuating from a storage system. So, the that feeder this word is known to you, we will be discussing here that some of the issues related to feeder.

**(Refer Slide Time: 01:31)**


And then we will be discussing about how they can be classified and what are the different types. And then if you are there to be designed that what things to be considered and then what are there exactly the basis of what you will be selecting for your particular need. It is very simple I

think some of you may be knowing about what is this. You can see this is also a feeder in this figure where this conveyor belt is being fed.

Here the material is coming from somewhere on this hopper it is giving. So, when the material is here at that time that this is going to feed over there. Here is also another you can see one small bin is there but from the bin the material which will be coming over here. We have a vibrating system over there where the vibrations we are putting taking the material out.

**(Refer Slide Time: 02:35)**


So, there are different types of feeders. Now what is the definition of a feeder? We have earlier also told once again I will tell you about this a feeder is a piece of material handling equipment that will be used for regulating the flow of bulk materials. Now that it is regulating this word is important here because when the material is going it will be just controlling at the time of giving it to the next equipment.

Now where you need such type of things; once as I tell if you are having a conveyor belt which is going at a particular speed. At that time, you will have to give your material over there, you are feeding it. Other thing sometimes there are different processes are going on from one process you need to give it to another process. Say for example you have got a crusher it is crushing the material from there it is coming out and then you want to give it to a screen.

So, that means you are feeding to a screen. Sometimes you are storing, from the storing you are taking it out. Sometimes you may be having say a feeder is also required in a machines like in a mining machinery like bucket will excavate or you are excavating continuously material is coming on that you are scooping it out. And then to take it away you will have to feed continuously on another conveyor belt. There how will you be using a feeder on the machine.

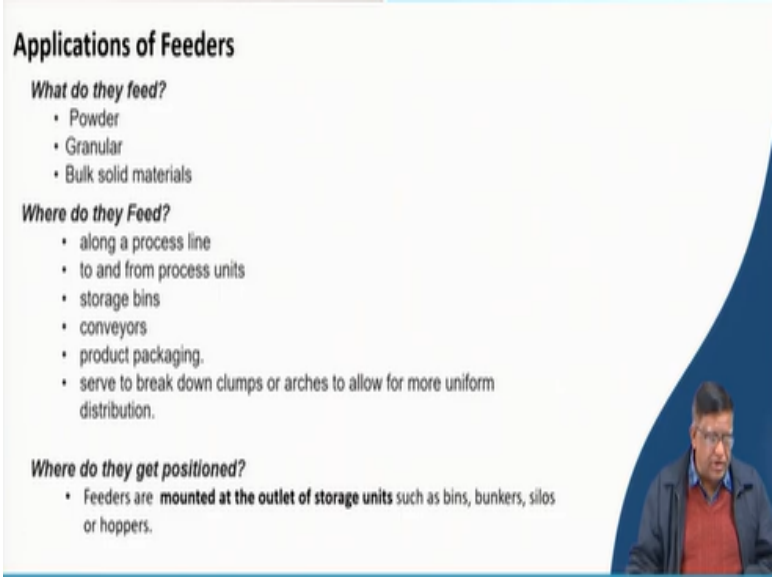
So, it is essentially it when you say the apron feeder or a belt feeder, coal feeder these are basically a conveyor belt. But what is there? They are not just like your any transporting conveyor belt where they transport a very long-distance feeders are used for a short distance transport. So, it is many a time we can tell that it is a transferring. Now the other point is it is the whole material is stored just above the feeder.

You can see here in this figure in this feeder the whole material is just above it. So, that is what will happen if this conveyor belt is there on it in normally on a conveyor belt you have seen in the calculation of conveyor belt where we take the cross section of the material which is over there. But here you are not thinking about that cross section of the material. The whole material at the top of the where it is stored there whole pressure is coming on to the conveyor belt.

So, there is the difference in feeder and a belt. That means in the belt you can find out in your any conveyor belt your belt was like this say on the different rollers. You had the belt your it is on a conveyor belt you have seen that this is on a roller you are having to say your belt is there. Now the material is over here and this cross-sectional area where determining your capacity which was giving different forces to the your this the conveyor belt was to be given a drive based on that pressure.

But in case of your hopper or a bin or a bunker or a silo your material is here. Now this whole material on a feeder, what is happening? This whole material load is coming over here. So, when you are taking out of it initially if the belt was here at that belt your this whole load is coming. So, that is why it will have to initially a big load will have to be carried out by the conveyor belt.

**(Refer Slide Time: 06:40)**

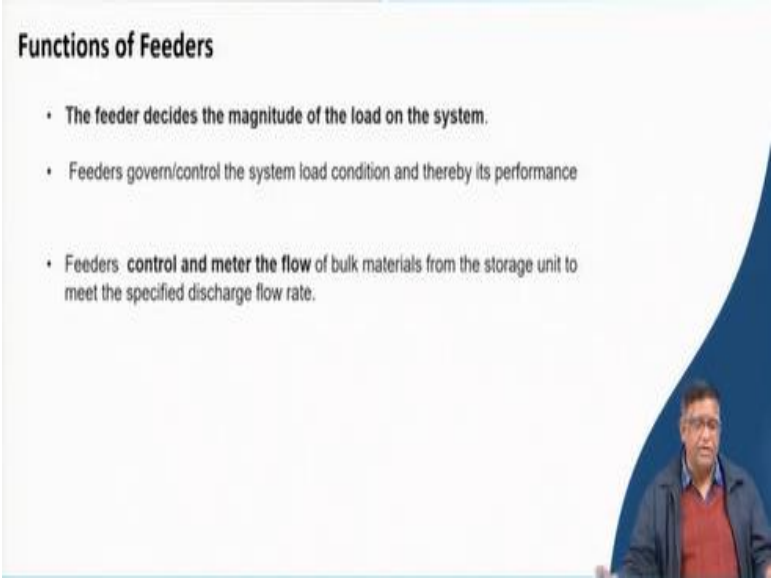



So, that means that it is not just like a conveyor belt but it is a taking up your load on the feeder for the whole material which is there above it. So, what type of materials may come on that? So, whatever you store you store sometime powder you store sometime granular material you can stick the bulk solid materials. Now what are those? In an agricultural sector you may say it is a wheat, it may even a rice floor or it can be your this sometimes you are storing say hay or that sometimes you are storing in the mineral sector.

It could be the cool itself will be there and then from there you need to feed so there could be different. Now they are feeding on to what? They are feeding to along the process line or to and from process units, storage bins, your conveyors, product packaging. Sometimes say for example you will be storing that somewhere that cement and then from there it is coming and you are making a packeting that is in the big you are putting it over there.

So, now the question is that where they can be positioned? In a plant that wherever the storage and wherever the filling that will be there. But that could be in your open type it could be in your closed type it could be anywhere depending on your handling system and the handling layout they can be differently.

**(Refer Slide Time: 08:16)**

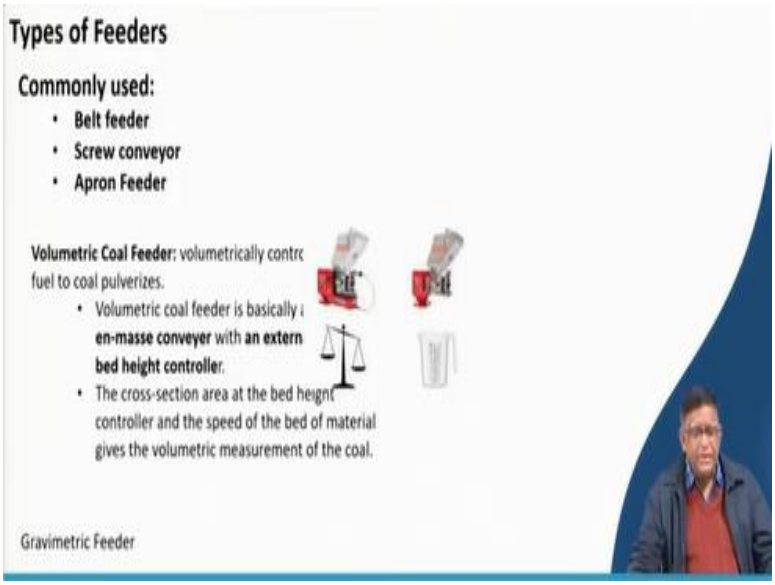



So, what exactly if we are thinking of selecting or designing a feeder, we will have to know that what are the functions it will have to be it will do. The feeder decides the magnitude of the load on the system that is how the load will be taken on to the feeder so the total the conveyor belt and all how it will be loaded because you are regulating. How, much material you are loading on to the next conveyor belt depending on that their power will have to be decided.

So, it is that magnitude and the capacity of the carrying capacity it depends on your feeding capacity. Now the feeder governs and control the system load conditions and also the material there how much material is going or how much is to be there whether system is running, full load or half load or no load that will be determined if we have a measuring system at the feeder itself. So, the feeder its function is to transfer the material.

That is your load the things give the feeding in such a way that it becomes that the operational problem does not come. At the same time to regulate you will have to do the weighing and measurement over there. So, this is what exactly they do.

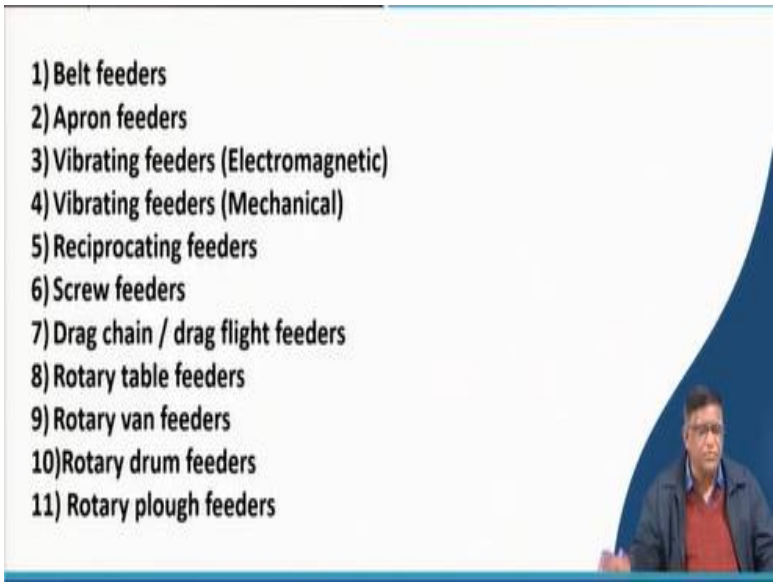
**(Refer Slide Time: 09:38)**




Then there are wide ranges of feeders. But the basic type that means whether you are giving material on volume or you are giving material as a measuring as a weight that is how much. Now why it comes? It is because our bulk material sometimes it could be as a huge quantity when we are talking of the mining and mineral or agriculture sector. There will be agricultural sector will be taking some 100 and 1000 tons of meter cube of material.

In mining they will be say 100, the 200, 300 meter cube of million meter cube of material they handle. But if you see some bulk material which are not coming as a package in the pharmaceutical in some of the your this in the cosmetic industry in some of the different manufacturing industry. But there in a processing you need to give a exact quantity either by the weight or by volume. Depending on that your the storage system or the feeding system will have to be there that whether you are giving a volumetric or you are giving a giving metric.

**(Refer Slide Time: 10:52)**




And then that there will be different types of this feeders. If I did not tell you earlier in the when we are feeding to the conveyor belt you may note it down here again that these are the belt feeder which is very common in almost all say in your coal mining and all in the you will find lot of coal feeder as well as in the boiler in the thermal power stations the coal is to be fed to the boiler. Sometimes what happens?

This coal is pulverized, it is to be pulverized before putting it to your boiler. Now that pulverized coal will have to be stored somewhere and from there so that means from there that your whatever the graded coal is coming they will have to be put over there. Then apron feeder this also I told you earlier that apron is nothing but a metallic plate that is the belt not a rubber belt or a special that is a just only a metal plate can be taking out whole load.

So, that because on under that load it will not get damaged. Then vibrating feeder is there just like give a vibration over there the material will go forward then that vibration it can be electromagnetically given or it can be given by mechanically. Electromagnetically means you are having that is your giving pulsations that make electromagnet is giving the pulsation. You might have seen in your door cooling bill that is how the vibration is given over there, the same vibration if it is given.

But the mechanically if you are having a shaft that is your having a plate on that if you are below you keep a shaft on which there you keep some different diameter day. So, there will be giving a different rate of pulsations will be coming the system will be vibrating. Only at the bottom you will be having some spring systems because of the spring system the vibrations will be coming up over there. So, that is a mechanically you can give your vibrations.

You can keep something and say in a incline from the spring is there and then when the load will be coming because of that it will start giving a reciprocating type of vibration material will be moving forward. There are different things can be there are available and you can also think differently. Screw feeder is another feeder, screw you know I think they say the sometimes you might have seen augers that your how when the carpenter comes, he might have seen that to make a hole.

They do these things you can see there is a your spiral that is your when your helical groups are there. Now when you do these things, what is happening exactly? In a wood when a auger is put through that helical part the material comes out. Exactly what has happened? It has conveyed the material out of over there. So, that is where if you keep a big screw with a big helical groove on a horizontal trough.

And then if you rotate and then from the top you are giving the material over here. So, then the material will be conveyed to the other you just take the hopper. So, that is a screw conveyor. Now that screw conveyor when is to be done in a short distance and all that thing it could be feeding it to the another one so that type of freezer is a screw feeder. It can be in a single screw can be taking the material or two screws can come together and squeeze the material out.

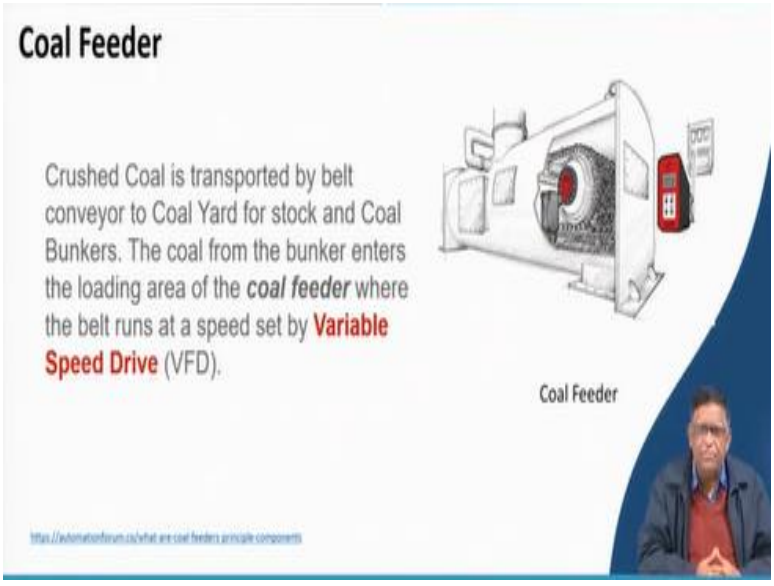
Sometimes rotary table is there that means your table is rotating over here like that and then your material you are giving a thing that exactly or you are pouring the material on a rotating table and there you are keeping a vertical plate. So, the material coming and striking at the plate it will be falling it down. So, that means what basically a feeder that is a your rotary feed dribble failure like that rotary van feeder.

If your rotating system is there and there you are some van is coming out just like (()) (14:36). If you have seen van pump and all you know while rotations then they create a force by which it will be going. In a drum if your there is a bin you think of there and then you have opened the gate and just below the bin a drum is rotating. Then what happen? Whatever the material will be in touch of this your bin and the drum that material will be getting just your releasing out of it.

So, that is your drum feeder. And this rotary plough feeder you can think of just like a impeller type. If you are having number of blades like this and you start rotating over there then each of them will be scooping out. The materials are scooping by a you can think of a fan type of things where the blades are there the blade are rotating and then if the material is there it is just scooping it out.

That type of ploughing, ploughing is nothing but scrapping and taking it out if you can make all different type of arrangements.

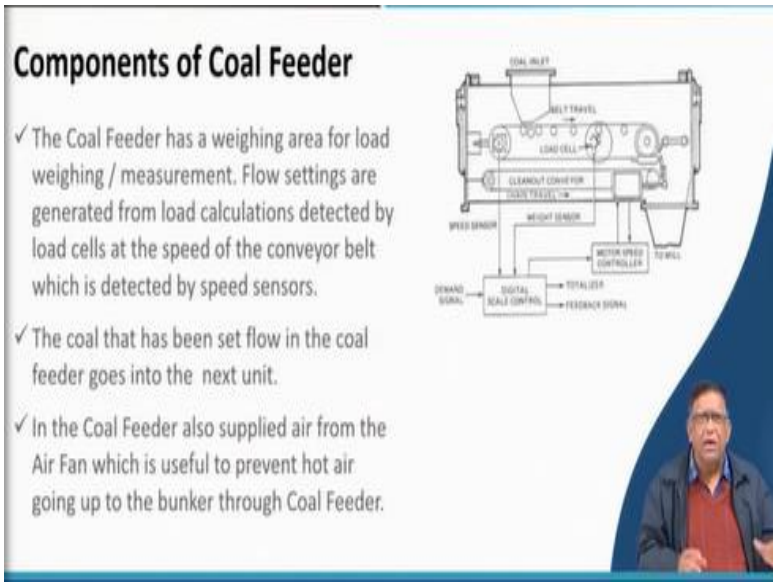
**(Refer Slide Time: 15:38)**




So, let us see few things over here. They apply in a coal this is a coal feeder. What is done here? That is a crust coal is transported by a belt conveyor to a coal yard for stock and coal bunker wherever is there from there it is taken out like that. Now the coal from the bunker enters the loading area of the coal feeder where the belt runs at a speed set by a variable speed drive. Now this is again in the electric motors electric sections you will be knowing about that.

There is a variable speed drive which can get that it depending on whatever the load is coming under certain load it can be running in a higher speed because the torque is the most important thing. If there is a more load coming to rotate it you will have to know if you have to reduce the speed because more material more pressure is there. But when there is a less you can increase the speed then the material will be going forward. So, that is the principle by which the variable speed drive is given.

**(Refer Slide Time: 16:43)**




Now what is there in a your coal feeder? If you can see here one thing is there very much that is the components you can see one conveyor belt is over here and this conveyor belt if there is any spillage and all there is a clean out conveyor belt this will take the material and again it will be giving it to be sand to the mill or wait it will be crushed for fine so that they are sending it to mill. Now what is there?

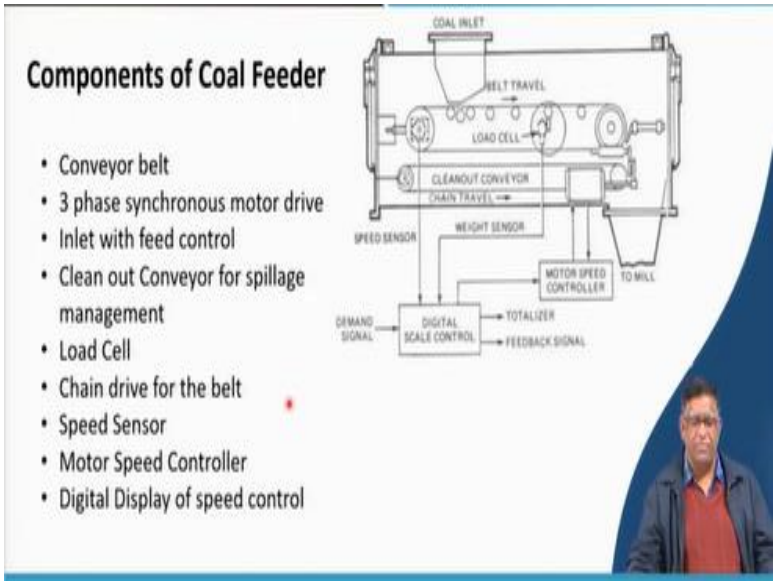
There is an inlet cool and then there will be the drive for this coal if there is a chain drive. Chain drive means there is a sprocket and this is a sprocket now on that the chain is going and that belt is exactly placed over here so, that the chain drive is there. And then there is a weighing system that is how much material is coming. So, there will be a way sensor it is a just you have got some your that load cell through that load cell they will be measuring it over there.

And then there digitally you can know that from the load cell whatever the signal is coming you can find out that how much weight, how much material is going on. Now you know that speed that speed also monitored depending on this weight and the speed you adjust together by digitally. So, that your amount of material which will be going that can go at a constant speed. So, this is how it is done in case of a feeder.

So, in a coal feeder there is a weighing area and then there is a particular flow measurement system and it is there will be certain fans. So, that your air which is coming that means sometimes here you may have hot air below that hot air should not come over here and then it will go to the inlet coal. What will happen? Then the cold stair is at that place there will be that hot more air will be going means oxidation will take place there, coal may burn by the what is called spontaneous heating.

So, to avoid that whatever the; air is coming over there that will have to be taken out. So, that types of things are there made in the feeder itself.

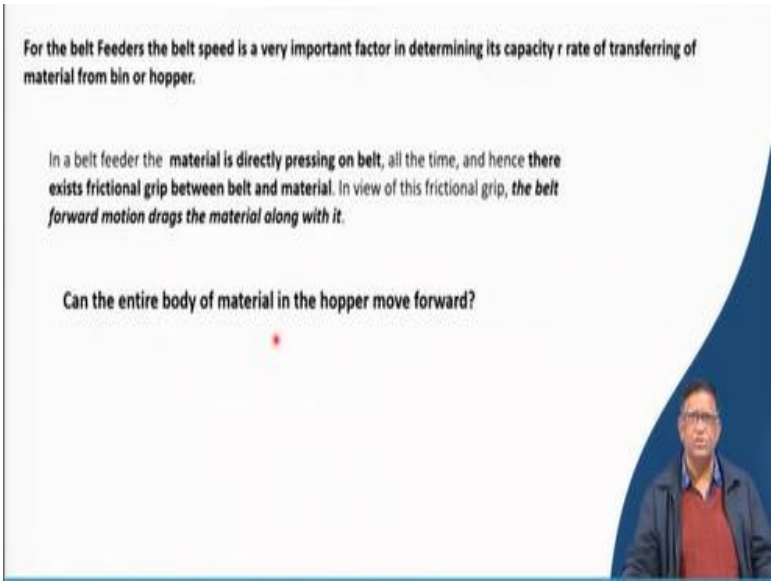
**(Refer Slide Time: 19:02)**




So, you have seen these components of the coal feeder once again you can note it down. There is a conveyor belt, there is a three phase synchronous motor drive, there is inlet with the feet control, clean out conveyor belt for spillage, there is load cell, there is chain drive, there is speed

sensor, motor speed controller and digital display unit. Now you know what are the main components and you can describe their functions together.

**(Refer Slide Time: 19:28)**

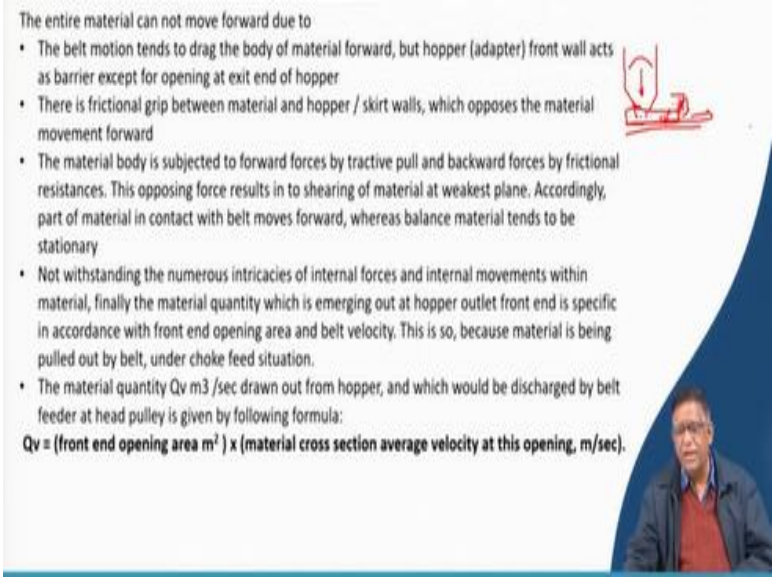



Now the belt feeders, the belt speed is very important and for determining its capacity. So, if you want to know the capacity or the rate or that is exactly you will have to know how the drive is given over there and that determining that speed in case of feeder is very important because it will have to take care of all the head load which is coming. Now the material is directly pressing on the belt because that it is stored from the all stored material is coming exactly the belt is flood loaded.

You can say there is if when you open the gate of the storage system that whole material starts flowing down. That is why the whole material now above the conveyor belt and there is a continuity of the material and this material will be giving a pressure. So, that whenever you have to move the belt under this existing load that is very important over here. So, now when it is connection load is connected over here now will all the material move along with the conveyor belt.

Or it will be only a part of it which is coming over there. You remember my previous lectures I have given you how exactly from the storage the material come in case of a feeder.

**(Refer Slide Time: 20:57)**




So, the entire material cannot move forward because the belt motion will be having a tendency to drag the body of material forward. But the hopper front wall acts as a barrier except the opening exit end of the hopper. So, whatever is there in the open end so that means it is at the back side this material is always as if it is static. Because it is having a vertical motion but the horizontal motion is coming only in the front side.

There is a frictional grip between the material hopper and the skirt wall which opposes the material from moving forward. The frictional things are pictures exactly what happens? When you are having this in a hopper, this is the storage hopper is there and then from there the material is coming on falling onto this conveyor belt. Now here is a skirt board, this skirt board portion that means this material which is stored over here.

This flows down as soon as and then it whole thing fall over here. Now the material is touching this skirt board this side and then exactly in the front you are having like that this is the front opening. Now whatever material this conveyor belt is moving in this direction then whatever material is in between here. These portions will be taking it out but the material which is touching the side wall they are having also a frictional resistance over there.

So, that generally whichever material is there they do not have that friction. So, when this conveyor belt is coming that material which is in the central portions it will be having a more

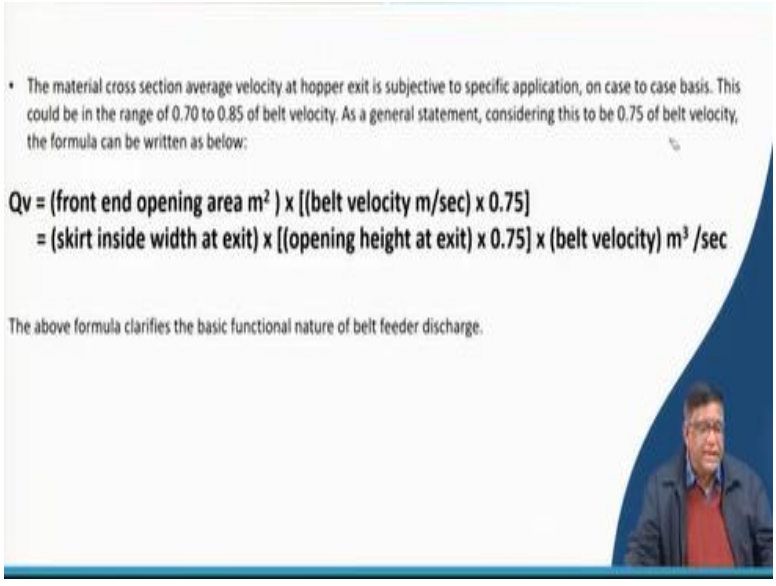
tendency to flow. But as because this is having a resistance of the wall, they will be having a less tendency to flow. So, that is why all the material uniformly do not go that is what is thing to be noted. And then when you are designing a system then we will have to see under what condition this will be giving you a best way of moving it out.

So, the material body is subjected to forward forces by tractive pull and backward forces by frictional resistances. In our belt conveyor class, we discussed about that how these forces come and do over here. So, ultimately that how much quantity will be going out to the conveyor belt from the feeder it will be depending on the front area. What is the area of this opening? Through is the material is going out.

And at that time what is the velocity of that conveyor belt imparted to the material. When the belt is moving at that time it will be importing because along with it whatever the material is in touch, they will be moving at a velocity of the conveyor belt. Now those which were there in touch of the wall they will not be getting that same velocity. So, that is why the material which will be going out will be depending on only in the front area, what is this cross sectional area.

And then at this touching point at the belt is going at what speed. This area and this speed will be giving you the material velocity.

**(Refer Slide Time: 24:35)**



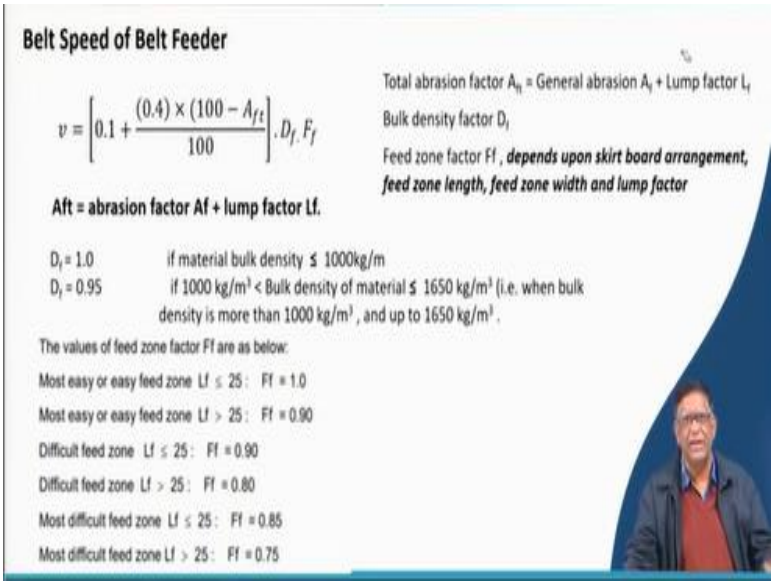
Now this is important. But what happens? There the whole thing will not be there only the depending on the efficiency of the system because of the friction and all that thing it may be having a 75% of that may go. So, this is the way how you will be that is that exactly the appropriate portion where it is there material is giving the sidewall that is called the skirt board. So, in this skirt board part you are doing it over here.

**(Refer Slide Time: 25:05)**


So, how do you control the belt feeder and discharge rate? Now we can control the gate by control gate or a variable speed drive. Control gate means from the bin itself you are allowing the material to flow slowly. That means you will be sensing that conveyor belt speed and how much material over there and accordingly you will opening or controlling the gate. So, that means your digital sensors it will measure this how much material how it is going.

And then it is opening slowly half of the gate is open so that the less material is coming. Then if it is going at a bigger good speed, you can open a little bit more. And this gate there are different types of gates are there that also you need to study.

**(Refer Slide Time: 25:53)**



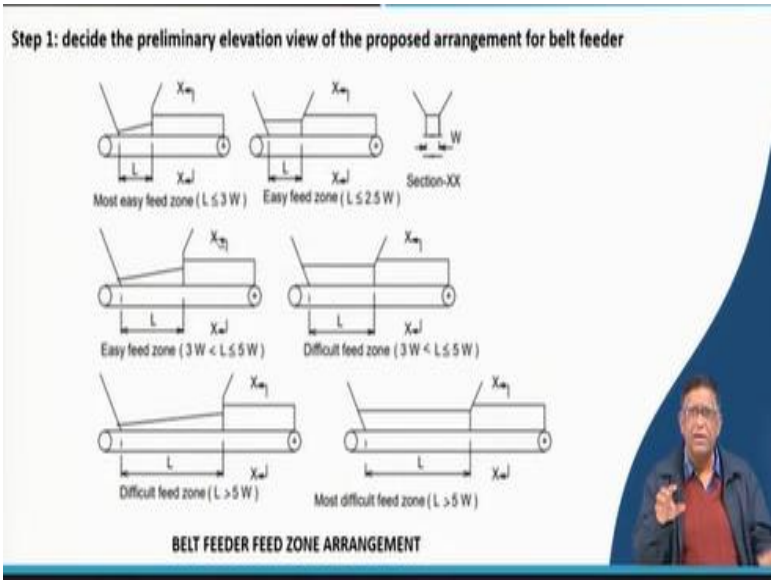

So, the belt, speed of the belt feeder it depends on number of factors. First is this what is the total abrasion factor that is your general abrasion and the lump factor that different lump sizes will be giving a different type of friction. So, that is why there is this factor that is a lump material when you are loaded the feeder will be having a different rate then the bulk density factor that is also one factor to be taken.

And the feed zone factor that means whether your the feeding part that velocity is getting all over this how much length in the bin or in the feeder that only a portion length is where the material is falling over there and the another portion of length where it is just going. Now their zone that whether it is a moving zone or this again you refer to the previous class you will find that there this zoning feed factor will be given.

And then normally this factor total abrasion factor it is the sum of these two factors. And then these values are normally your density vector and then your the bulk density factor for the material if that is your density is less than thousand kg per meter cube and then we are getting one and if it is more we are taking it less. So, that is a thumb rule followed and then regarding this your different lump factor depending on the lump sizes their value are different.

So, by that from the feed belt design or feeder design handbook you can find such type of equations. When you are going to do an exact design, you will have to do it.

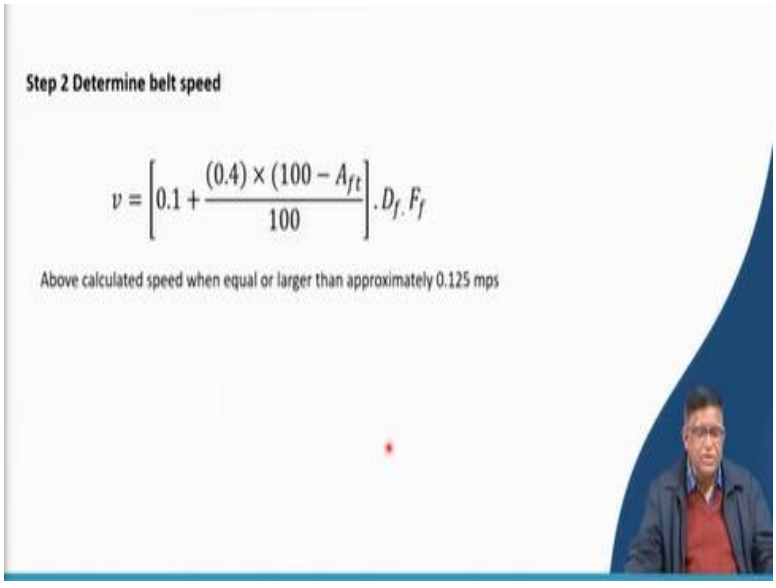
**(Refer Slide Time: 27:39)**




Now that zone which we are telling that means your belt feeder zones that where the belt is having a this much long of skirt board or it is having your this is the portion of the skirt board. Sometimes you may have a this whole material here if this L is longer here the material which is getting loaded on this d is also getting a velocity and coming over here and then put it. So, this different type of designs could be there.

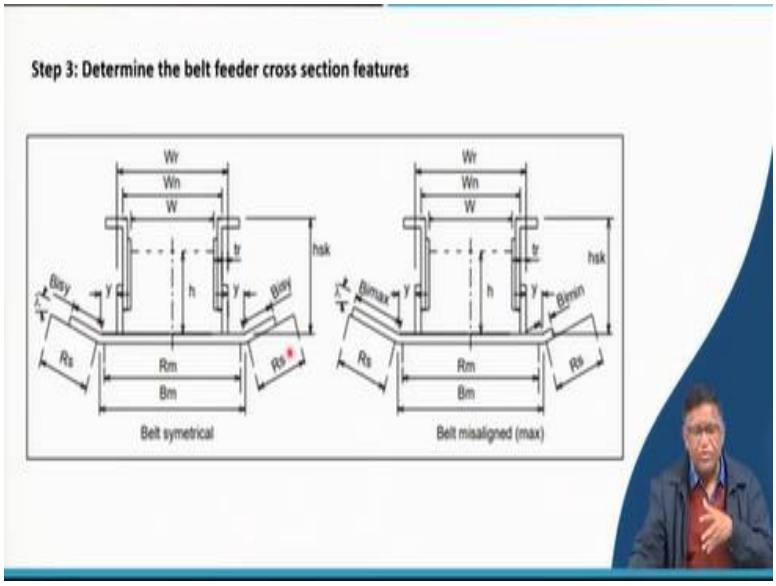
So, they will be affecting your flow differently. As a design they do the number that is your then go on doing iterations and that whichever is the best data is selected.

**(Refer Slide Time: 28:28)**



So, this way once they find out this that the first thing you have to determine the velocity. For that you will have to know the different factor.

**(Refer Slide Time: 28:36)**




And then in this skirt board the front side what will be that these dimensions will have to be created that is your whether that built. That is the total belt length and then the belt will be sometime if it is shifted. Now then the whole system will be different. So, here you can see the belt is having a centrally running. So, under different conditions your feeding load will be different. So, this is just for your understanding we are not going to the detailed design over here.

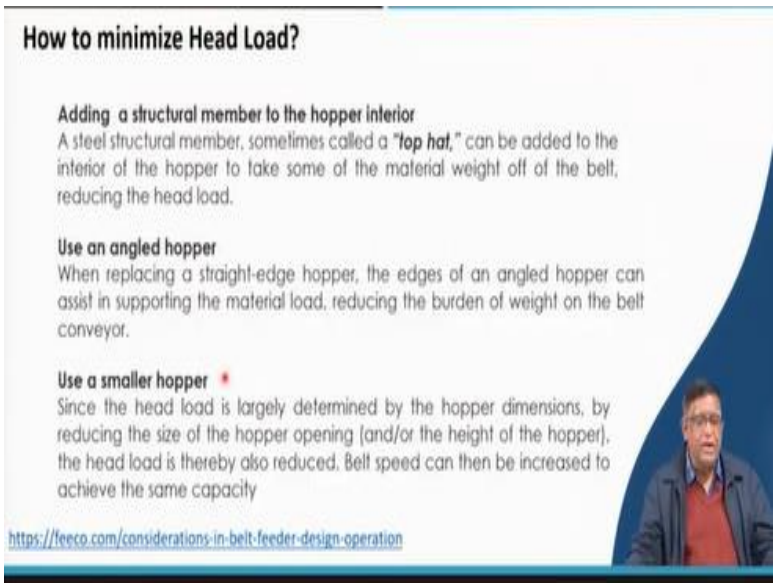
But you must know that when a skirt board is fitted to a conveyor belt that conveyor belt inside that how much the material is receiving this area height and this area that is very important for knowing the capacity.

**(Refer Slide Time: 29:24)**


So, while you are going to do for this design, the influencing factors are the head load, skirting, variable frequency drive for giving your variable speed and the belt scales. As I have shown that these four things the head load is the total load which is coming on the feeder. Because of that this is in the conveyor belt design their force gates this head load do not come. But in case of your feeder design, you will have to do head load.

Because it defines the power required for to drive the belt. Skirting that is skirt board part as I was telling and then the variable speed also, I told you.

**(Refer Slide Time: 30:07)**



But what happens if you are having a very tall tower silo? From a tower silo that if you are putting over there the whole load if it is taken on the feeder bed to drive it you will have to have a very high torque such a high-power electric motor will be necessary. So, that is why they do sometimes that is your in the inside the hopper they make give some inserts by adding a structural member inside the hopper.

So, that it will take the load; the whole load will not be allowed to come to the feeder. So, that means you are having a scaffold type of system inside the hopper inside your silo or hopper then the material will be going only that whatever is coming over there. So, if you are keeping like that a control opening and closing of that by that way by a structural member you can reduce it or you have seen that hopper bin is like that.

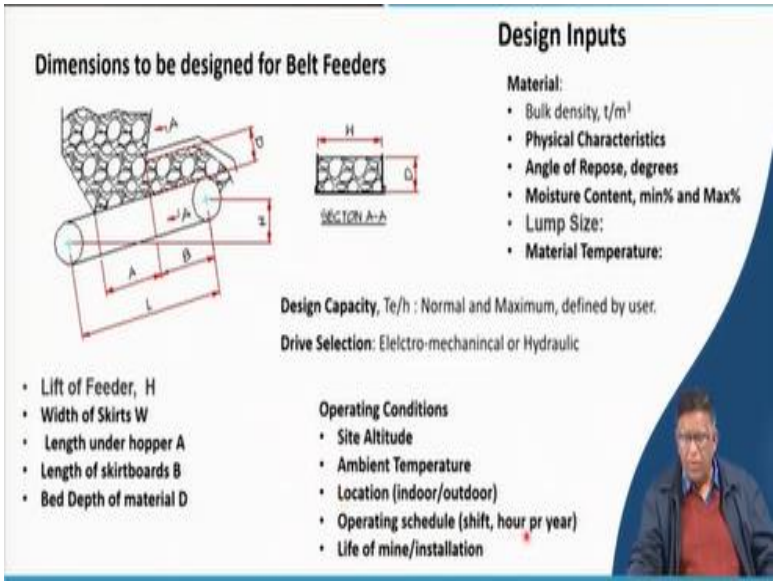
If you make a inclined phase like this you might have seen with that load that there will be a kick load and then the overall the load on to the feeder will be less. So, then another thing is there if you take a small hopper from the main silo, you are taking over there the material you separate it on a hopper and there is a small. So, that very small height load will be coming as a headload to the other. So, these are the things you will have to think how you can minimize this head load.

**(Refer Slide Time: 31:35)**


So, that your drive power required to the feeder will be safe. Then the skirting or the belt feeder increase the feed rate or the capacity from the skirt board exactly sometimes your the concept of

the operator can overfill. It can it is operator to be given that means they will be controlling the gate and then by that they how much material is retained within the skirt board and then how it is released that is the thing of controlling the whole fuel system.

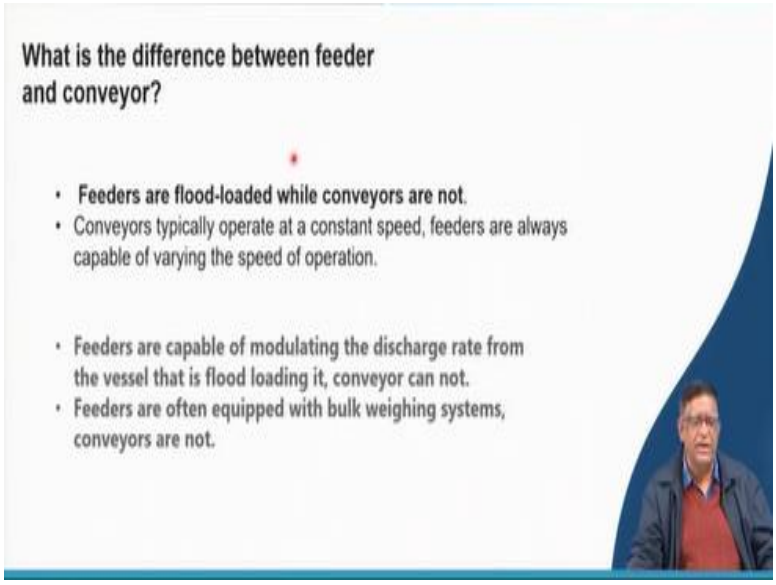
**(Refer Slide Time: 32:08)**




So, you can see here in a design of a feeder you will have to type find out these dimensions. That is your what is that your total length and then how much lift has been there and then if you see from front side that what is this width of that and then what is your exactly total under that hopper how much is in this portion, how much is in this portion this makes the whole design. And ultimately you will have to find out what is your design capacity and what is your drive selection.

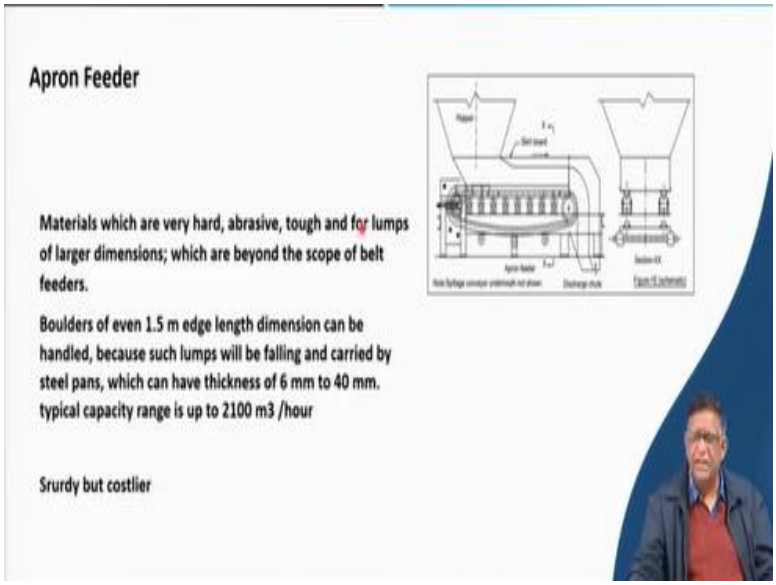
So, that main input parameters for designing is the bulk density, your physical characteristics angle of ripples, moisture content, lump size, material on the basis of that you will have to do the design. And then your design will be based on the operating conditions which are the site altitude, ambient temperature, location, operating schedule shift, hour per year and then your number of the; what is the life of the mine or life of the installation all these factors are taken into designing this.

**(Refer Slide Time: 33:09)**




So, the basic difference between a feeder and a conveyor is then feeders are flood loaded whole the material come over there and they will have to be high torque must be applied for driving it. In a conveyor belt it is just a loading is not by the head load is not there. So, compared to the feeder they may have a low power to supplement.

**(Refer Slide Time: 33:38)**

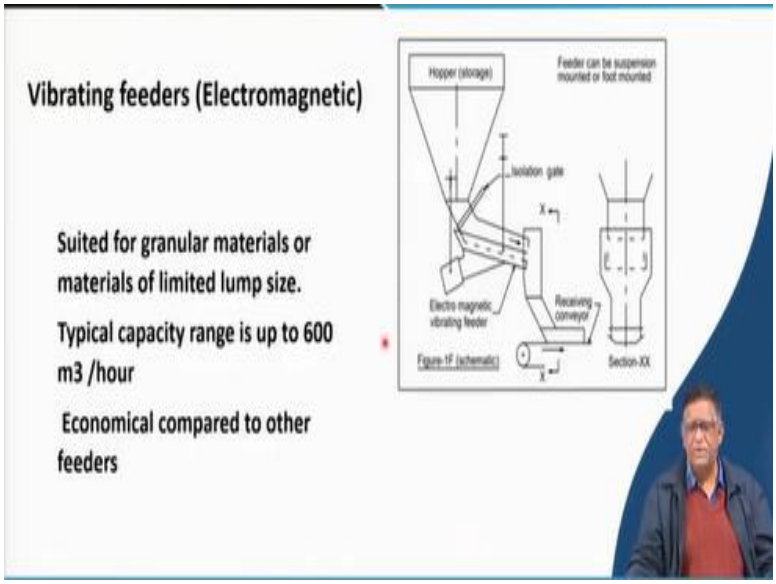



Then there are different types of feeders are there. You can see that there are apron feeders which is exactly that we discussed earlier on a metal plates.

**(Refer Slide Time: 33:49)**

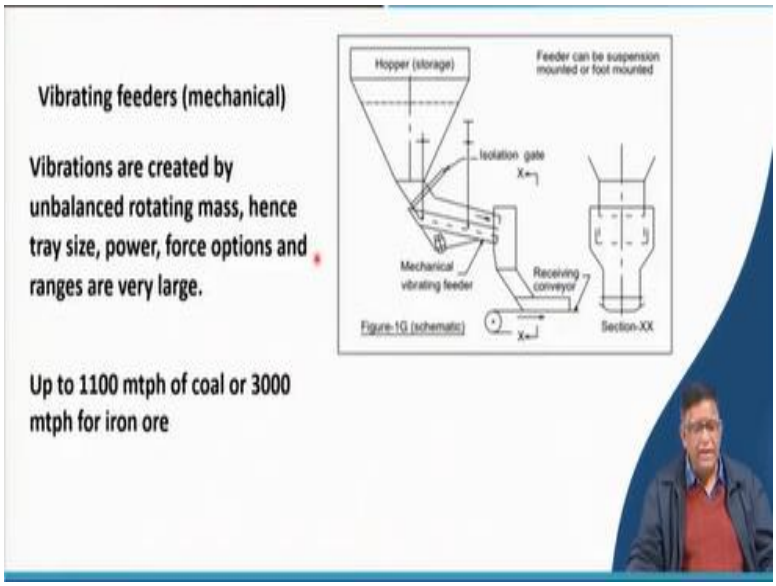

We have got this type of feeder is called your apron feeder; this is a belt feeder we discussed earlier also. You need to do these things as your self-learning study, please find out what are the difference of this type of feeders.

**(Refer Slide Time: 34:01)**



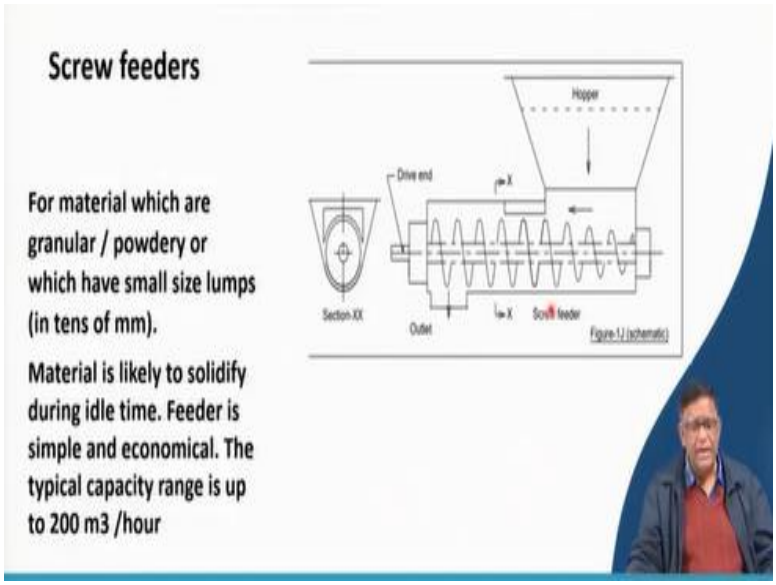

A vibrating feeder where the material coming from a hopper this portion is given a vibration by electromagnetically then the material is coming out of it and then loading into the conveyor belt.

**(Refer Slide Time: 34:14)**




Similarly, in your vibration can be given by a mechanical means without giving an electromagnet, you are giving a making it to vibrate. So, that the whole material which was getting flood loaded over here. From there it is loading on to true distribute to the conveyor belt.

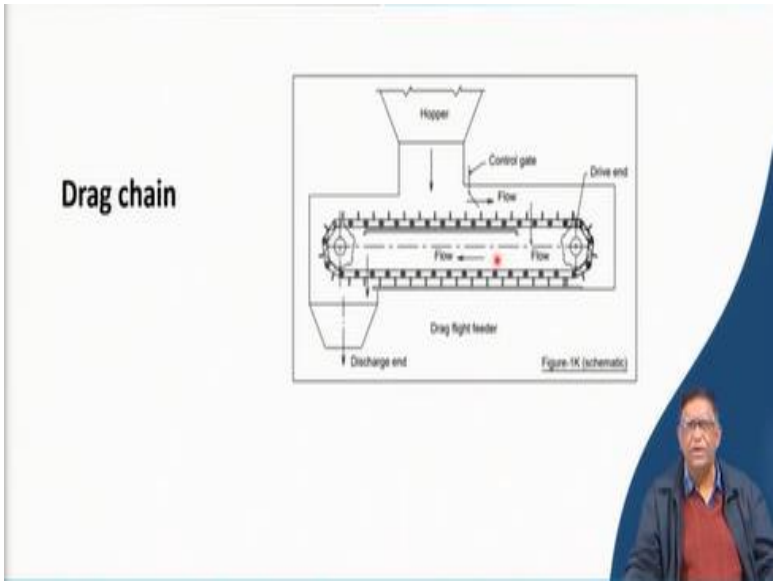
**(Refer Slide Time: 34:29)**




Screw feeder as I was telling a auger type of things will be there, material is coming on to this hopper and then it is rotating and then the material will be going, outlet will be coming through this. So, this type of feeder is a screw type of feeder, this feeder can be used up to 200 meter cube. But if it is a very sticky material, you will not go for it. So, that is a something or many times coal and dry coal can be easily taken over here in the agricultural sector.

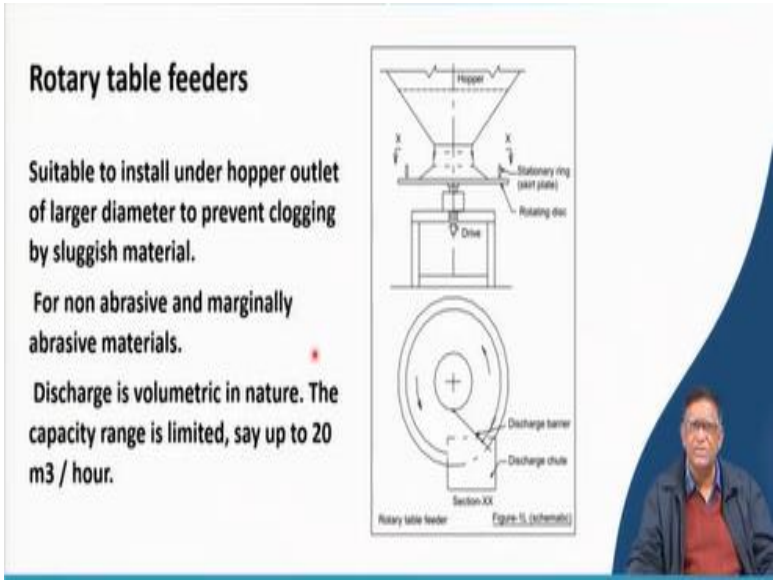
It finds a lot of use. You can go to any some food factory food manufacturing factory you will see lot of screw feeder.

**(Refer Slide Time: 35:03)**




Then there is a drag chain. This is you have seen in a in some of the reclaimer of there where a chain is going and there are the flight bars. This flight bars will be pushing the material from here and it is going. In a scrapper reclaimer you have seen this type of system over there.

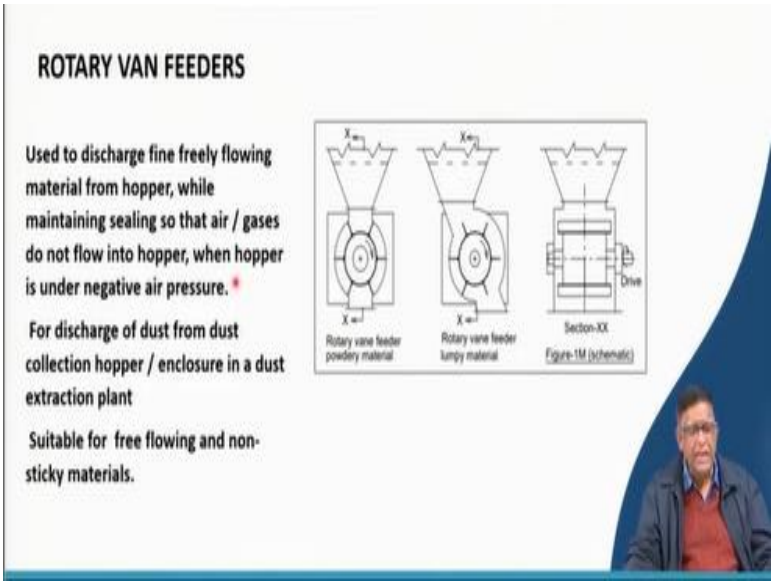
**(Refer Slide Time: 35:20)**




The rotary table feeder you can see from the plan view this is a table which is rotating and there is a discharge the barrier, one barrier plate is there. So, when the hopper material is coming and

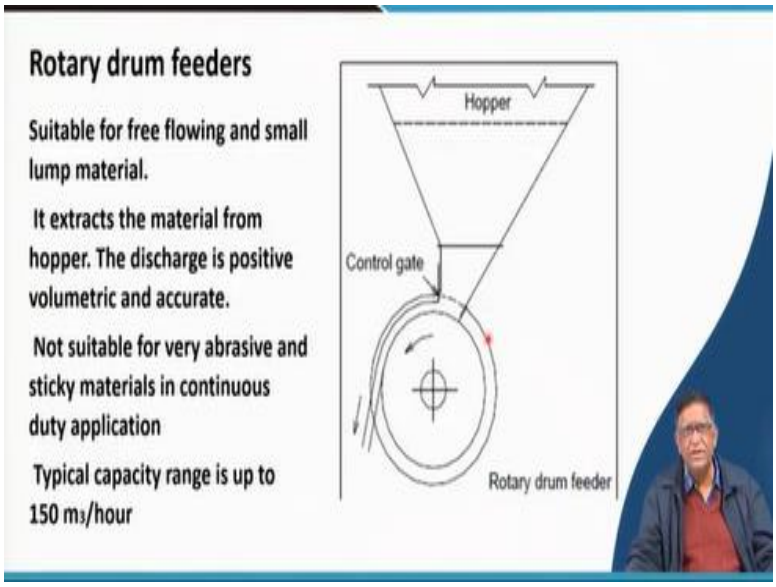
falling on to this particular rotating table or rotating disc is there and as because this barrier part is coming the material will be falling over here.

**(Refer Slide Time: 35:42)**




Then the van feeders that when this is a drum it is rotating over here, these vans are there so these vans come out so in this portion the material gets stuck. So, whatever the material is coming it is guided through this and then it is coming out.

**(Refer Slide Time: 35:57)**




So, these types of feeders are there. Rotary drum feeder as I told you that from the hopper the material is coming out of this, this drum is rotating. The material now which has got flood loaded or contact with the drum, this will be coming and falling it out.

**(Refer Slide Time: 36:09)**


So, there are different types of things are there. Please try to find out from the literature that these different type of feeders how will you compare and, in their constructions, what are the main design. So, that is how the different forces are coming and to overcome that forces how the power will have to be calculated that is the main objective of designing.

**(Refer Slide Time: 36:32)**


So, we have just given in a very briefly different types of feeders and then design approaches, what are the main factors to be considered and then some general ideas of their application also I have highlighted. But what you will have to do for designing and using you must follow the

manufacturer guideline. So, as a learning activity please try to make a table of at least five different type of feeders by each of you.

And write down their specifications what is the driving power, what is their exactly what are the features given, what type of material they handle, can they handle sticky material, can they handle powder material, can they handle bulk material, do they handle a separately that screen material or it is just only any type of material it will go, do they work, how they in a hot, what type of temperature hot material can they take up or do they take only in the cold material.

Do they do only in the indoor type of applications they can be used or they can be used. So, there are different type of queries will be coming to your mind when you will be going to searching those the technical literature of different company. As a part of your learning make a habit how to read or the different advertisement leaflets and from there whether you can take out some of these things.

If you are becoming an engineer capability of deciding by reading the advertisement leaflets is also things. So, you take those materials and bring those things to for your group to discuss to take a problem of designing it. So, I hope you understand this part and we will be continuing our discussions on bulk material handling on another topic next class.