Bulk Material Transport and Handling System
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Lecture – 24
Introduction to Silo

Welcome back, in our discussion of the covered storage system for bulk materials, in our last 2 classes, we discussed about the bin and bunkers. And today I will be talking about the another covered storage system which is called silo.

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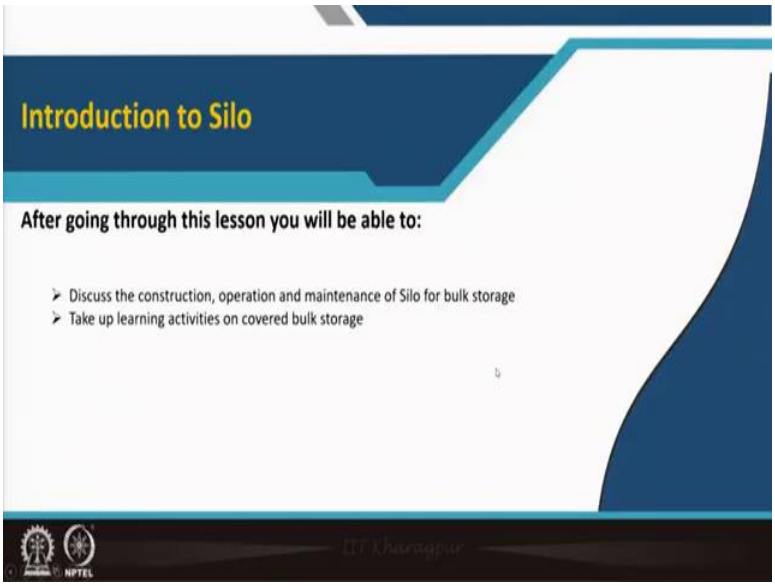

Now, after this lesson, you will be able to discuss the construction operation and maintenance of silo for bulk storage. And the end we will be discussing that in which way you can take up some activities by which whatever you were learning and then how you can apply this to the real life problem solving, you can take some activities yourself at your home. So that is what is our purpose today.

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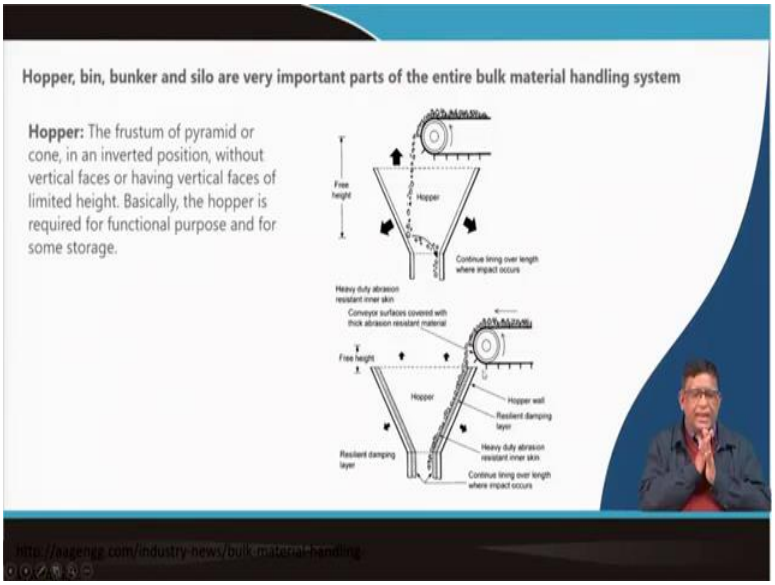

Now, just to recapitulate, we have talked about this hopper bin and bunker which are a part of this our storage system. If you if you just remember we have got this hopper a funnel ship things which exactly receives the bulk material and then it taking particularly the material is entering into this and then it is just allowing it to go to the next appliance or next processing equipment.

And in that Hopper if you remember that depending on the hardness or depending on the abrasivity of the material, we are having this liner and then we used to have that certain things that it also that whatever the speed at which it is coming it get dampened. So that if you are not having the liner at a very high speed it will be falling and in that speed when an abrasive material will be going to a hopper wall will be that will be getting your it will get wearing out.

So, those and this hopper which become a part of your in a bean or a silo and the bottom part for evacuating in bunker also very very work waiting this hopper is a very important part of it.

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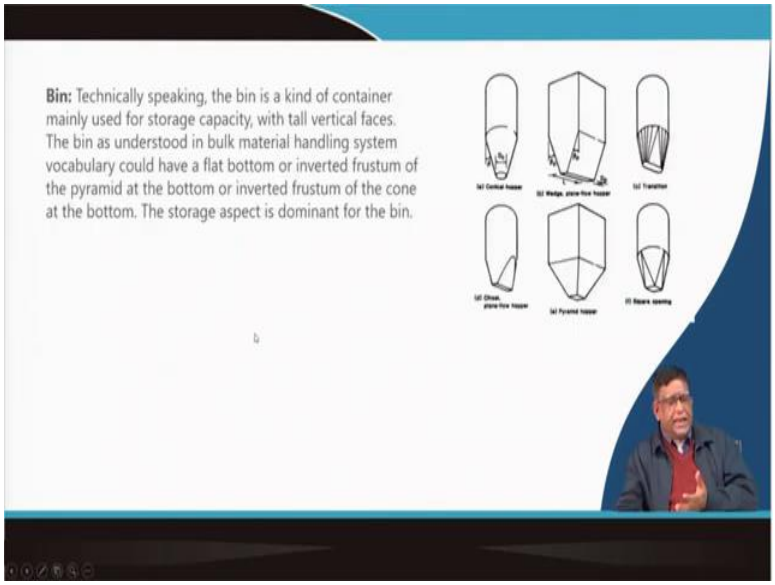

Now, you have also seen bins that is which is a container comparatively smaller and they have got a different shape and size. We talked about their cylindrical main vertical part or the rectangular, sometimes as a square type and then at the bottom the ditches also can be circular or can be rectangular or pyramidal different type of beans are there and we have seen how they are used in the bulk material handling system.

Particularly you will find them in even in liquid handling in some of the milk processing plants you will find there are different types of bins used, you go to any food processing plant, you will find the beans that storage until coming there they make a very high quality send stainless steel and so that no contaminants and other can come lot of steps are taken in the bins so that we get a hygienic food.

You go to any Nestle company's, noodle making farm there also you will see bin. If you go to any pharmaceutical plan where they are making this tablets and all by from making different ingredient mixing there also we will find smaller capacity bins. So, the bin is also used in our storage in some of the that supermarket for keeping the materials yours this grocery shops, they will be having a bin we can have a very mechanized type of your opening.

This is the thing where you can also take some innovative way, the things which are kept in our many of the shops that is your rice things and all, if instead of there they will have to take out from the outset the opening is kept very wide open. You can see near the road side, the a lot of dusts and sometimes even that so many things that come and they mix under exactly air it is exposed to the reverse air.

But there in those grocery shops and all where they are selling rice, dals and other things, if we can design a very good close to being with a gate system and if it is becoming cost effective and as well as very convenient to operate. And even you can think of having a bin with an automatic weighing system. That means, if any person wants to buy in a supermarket amount of material, he can just press the button and then get the exact quality of the material release to the gate of a bin.

You can have there that even a 30 kilo 40 kilo or 100 kilo bins that different type of bin you can take up as a small innovative experiment that is in which way we can have design our for our grocery shops, a bulk material storage. The bulk material, their rice, sugar, spices and all this different type of things. So, if you can design something that can bring a cultural change the way our the shops in small towns and all they will be kept. So, this is where your engineering idea and input can give a view good business also.

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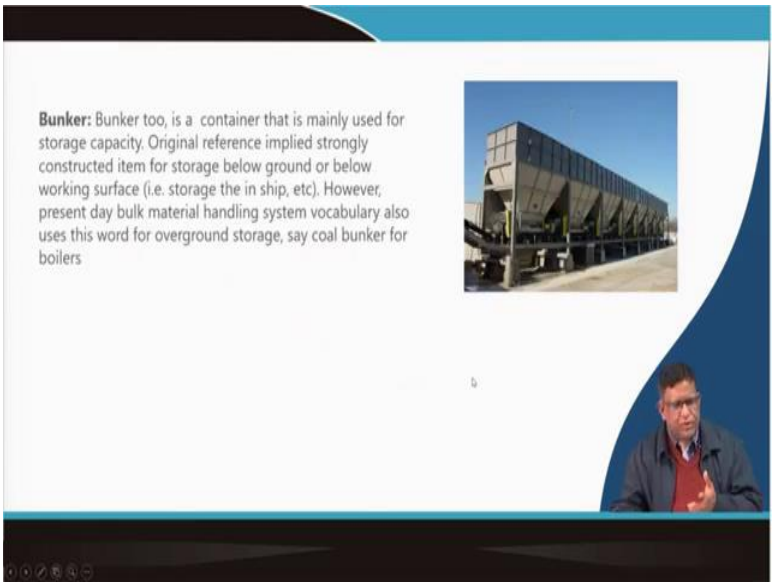

So, other things we have discussed in our previous class about the bunker that bunkers are of different types that is also a container which we have discussed last class, about how it can be a ground mounted or these type of things. And then when I asked also that you must make a visit to a coke oven plant or a thermal power stations where these bunkers are there. Now in invariably in most of our plants, like your thermal power plant or in any Stumen plan.

You will find the fuel coal which are brought over there many times it is there keeping as they open cold storage. Now, by putting them over here only problem is there is a capital

investment on making this ones but for the environmental services that will be giving it ecosystem services that it can give if you evaluate their costs that is your investment or capex for this type of infrastructure could be very useful.

Industries at a higher level while they are planning their capex, they can find out that this investment at what time after how many years it may get the break even point and then it started giving the return on the investment. So that your bunkers we need to change some of the open cold storage to this close cold storage that is also there you have seen about different types of bunkers.

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Today, we will be discussing about this silo. Many of you might have seen this silo while you are going by train or by thing near a thermal power station. There you can see this type of storage system cold storage systems are there some silo for you have seen wild tanks and all that is also a different type of silo for liquid storage. So, here in this diagram, you can see it is a thermal power station, where this coal is stored over these 2 big silos.

And they are this capacity sometimes can go even 10,000, 30,000 even 100,000 meter cube of material can be stored over there. Now, this silo in recent years have come in a very big way because they are environmentally friendly, say coal can be stored over there and it will not give environmental problem. But there is of course, some problem will be there because the cold dusts which will be getting accumulated over there and air which could be there that air in the coldest mixture, it can be an explosive things and under certain conditions, it may bursts.

Then such type of silo and collapse because of those cold dust explosions can take place. So but for that the design today, because we know that sustainable phenomena may happen the chemistry and the physics of this explosion that is known. So that is why it can be done both the ways. Even if explosion takes place the structures can be made robust enough not to collapse and then we can eliminate the causes of this that is the excess of oxygen into the system excess of air and the generation of dust by proper monitoring and evaluation systems can be given over here.

Those type of problem we will be discussing about how the silo may failure and that problem and what type of solution is there. As a result, the silos have get it have got a tremendous popularity in the near just last 4 or 5 years. Even you may see something that I think some of the Netherland companies they are doing a all over the world that the Euro silo one of the very robust big silos they have erected and also even under the COVID situations.

There is a exemplary erection by this European companies of a silo in Shanghai in China, they have made their 100 meter cubic robust silos structural that is reinforced concrete structures of a huge size they have developed. That is you will be appreciating if you see some of the YouTube over there and then some of if you just search you can find out how such type of things can be controlled and elected by supervising through internet.

During this 2020 December, it was commissioned at that time that nobody was there in the site, they were burying for few people only but the whole precision control and all were being done by the internet system of things have happened during last 2, 3 years. So, you can make asserts that what are the resent silos that have been constructed, now, we will be coming to discussing about what are the different types of silo.

But you need to know that the silo can be constructed by different for different material differently. Because that as we said earlier also in whole bulk material handling the material characteristics, it makes the whole difference in which we will be designing. So, it is what is the main drop the main advantage of this silo is if you take your open storage that other than the lot of dust going out, it looks ugly that aesthetic of the area get destroyed.

Because even the trees nearby you will be having a black leaves. Then the second thing is your area required for a particular storage, say for example for 1000 meter cube of 100,000 meter cube of coal to be kept near a thermal power station means a large area will have to be having a heaps of pool. But if you are having a silo it could be maybe diameter 25 meters or 10 meters high load and because if you are keeping vertically.

So, in another way we can tell that the environmental footprint, the footprint of this silo will be much less when compared to storing the same material in open storage. So, the silo system with a minimum footprint today moment may come and that is why silos have become very popular. In India, we had the silo constructed by engineers India limited by Elicon this company they did in a in the silos started big big silos were constructed during the 70's and 80's.

If you go to many of the coal handling plants and also the say giant or that northern coal field Coal India Limited they introduced silo long back in some of the mind chain that were the **(()) (13:13)** round system of transportation of coal to the thermal power stations in near the giant cool field it is there. And then recently because of the environmental process at the last couple of years that Coal India is a making a lot of railway that rapid loading system for wagon by making this silo is a part of it.

So that silo design, silo management, silo control, silo main filler, silo maintenance, these are the area and topics where it you can get a lot of reason and new information and where you can also give your contributions.

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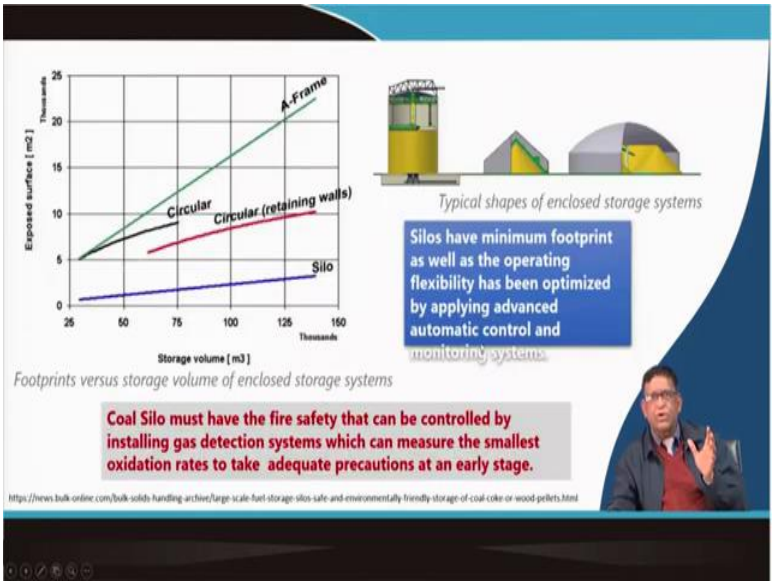

Now, it is just there that when you talk about the silo or that closed storage, closed storage can have a shape type of things that is a it can have a circular shape or it can have a rectangular A-frame type of structures could be here but or that silo can be there and out of all this tray. You can see that expose surface that requirement for silo is low less than your that 5 meter square area.

But where is in your A-frame type of circular type of other type of cold storage also they have got a you need the more area over there. So, the silos have the minimum footprint as well as operating flexibility has been optimized by applying advanced automatic control and monitoring system. That means silos are now you can make it, it can be adjusting to the requirement that even in the low capacity silos are now it is coming in a modular way.

If your some operations you are having is so, say only 3 years or 4 years type of operations are there, you can transfer that place to another locations and now, such type modular silos are also coming up. So, this is a advanced way of storing cool or that is for temporary storage for handling in between the processes.

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Now, coming to this one thing you should know that silo is a not a new concept, even in the 19th century, there were silos. Of course, those silos were mainly in the agricultural sector for the grain storage and all and this was having a number of different type of silos, you can see made of welded steel, there are a bunker silo which is having a bunker along or that is taking as a bunker silo, then there were the concrete silo, there were tile block silo then metal ferrous that is metal that you are using these still are that shell type of silo.

But that the silo term is that being used also synonymously for a large storage. That silo that word from the grain storage it has come even you can see in literary also they have means that what are the things in the silo that in the language also it has got a different meaning.

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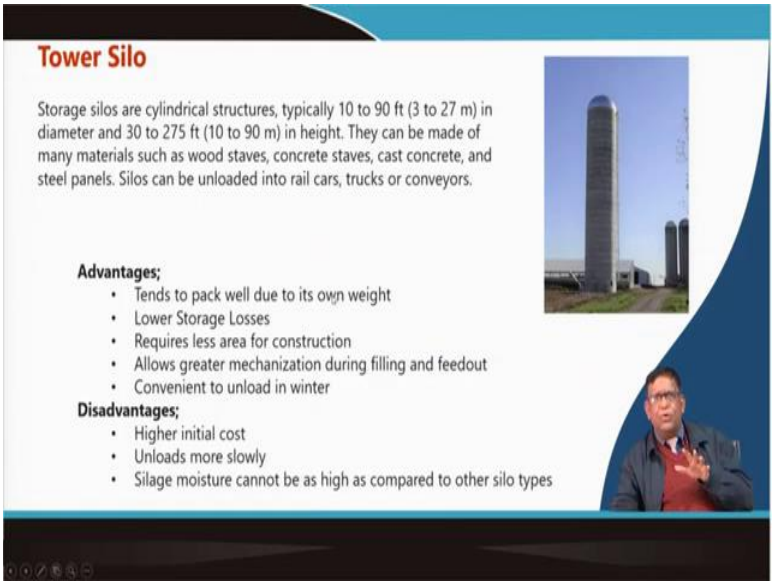

You are not going to that but this silo what we can have the 3 main types that your tower silo your big silo and the silo pile. That were in tower silo, you can see it as a gigantic tower in which the material is spread. Now, normally such type of big tower the material is always fed from the top and by a conveyor belt or other bucket elevator, different types of we will be discussing those bucket elevator and how it can be worked with a silo that for storage purposes.

But this tile silos they unloading will be always below it can unload to the railway or do not it can unload to the cars it can unload to the conveyor, whatever that system is there. So, when we talk about a silo, it is a storage but we should think of a silo system. Because only the silo does not work, it will have to have a the receiving system or receiving mechanism and it must have an evacuating system and evacuating mechanism.

It will have to be a monitoring system and it will have to have a reserve control system, all these 4 systems can be considered as a subsystems of a what we say as a silo system. So that systematic approach, you need to understand if you take like little bit of research, you can go how can you optimize the system? Optimizing means whether the how you can minimize the cost, minimize the problem, minimize it say that is your maximize its utilization, those are the way how the system studies are done.

But things that here when you use a silo their main advantage, it is it gets will packed. When you are putting the things over there it will get packed automatically by itself. But if you make a very high pack then what will happen the compaction level at the bottom will be much more it can be very hard sometimes. That is why, Eurosilo that Netherland Company when they make silo, they are having inside that silo the material will be put and then there will be a sticker inside.

It will be just layer by layer the material will be dumped and then it will be the sticker will be going climbing up the pile and it is tear. And when it is to be evacuated at the bottom, there will be a screw conveyor that this screw conveyor will be taking the material out and give it to the discharge point. So, there is no question of getting an arching or bridging or the flow problem.

So that is the let us in a very large silo, you should see that, that means how it is being filled, while you are filling, if you allow the whole material to come from the top if a coal if it is coming over there then there is a, the whole coal will get shattered, there will be lot of pulverization and powder will be formed and slowly it will be a situation of coal dust explosion. So, in such type of cases that coal will not be dropped from the very top to get it pulverized.

So that is why but thing is that you can stuck it make it over there and accordingly other ends when can be done. Then because it is in a closed thing, there will not be any loss of the coal during the storage. You may find wherever the coal in the open storage it is there during the rainy season a lot of coal fines and all will be going into the drain. In the drain nearby coal pile you find that somebody can just take a cloth filter and take the all the coal particles can be collected and they can take home for their burning it for cooking purposes, it happens.

And the pilferage that means that when from the coal storage, a lot of stealing also will be there and then from the store, if you are keeping an open everything you can cannot collect, you have seen in the reclaimer class also when you are making the pile that reclaiming the that from the age one you need to push by a dozer and then need to give it.

That means for your there is a loss and also for collecting it you will have to do those means to pay for the dozer operator, you will have to buy that you are the dozer for each capital investment also the diesel we require lubrication oil, we require for the running the diesel and all so many costs. But if you are keeping over here, there is no spillers, everything is there inside and you are in the hopper and from there you are evacuating and collecting.

So, and then there is no additional manpower required no additional fill energy required. So, you can do it very well. And as you have seen that it can be constructed in a very low less area. So, the surrounding and everything can be very well maintained and manage environmentally friendly way. And you can easily have an automatic level monitoring system that in the silo, how much is there now, how much is filled, how much quantity it can receive those things can also be very easily put together.

The other thing here the weather or the climate rainy season and then in the cold countries, the winter season snowing and all these things will not affect you. So, this is one of the big

advantages. But what is there initially in open storage, you do not have to spend many money you just have you buy a dozer, you buy this fountain loader, you bring a truck and then your things will becoming just to that is no need of any use capital expenditure that is the things where exactly in our country, we have not gone for much large capacity coal storage.

We are we always used to think that we are not a very rich country but no we are not poor but we have never considered getting investing in those type of to make the things look better and to make the things beautiful. Ours is **(FL)**. So, because of that our designs in our industry even in our home even in our institutions, everywhere we do not go for beautifying we do not like to spend money for creating certain avenue.

So, these advantages the higher initial cost and unloading is slower. Now that is whatever has been design with that you cannot increase but if you are in an open storage, by one front end loader I will make 5 front end loader five times I can increase the loading rate but here the loading rate will be whatever has been designed all the time it will be going continuously.

So, if you have well planned considering your situation is very good otherwise this is a disadvantage. Then silos moisture cannot be as high as compared to others silo types that is what happens that if you are keeping particularly in a the silo is your where you are keeping the tasks your grass and other things over there if you are open one there will be a lot of moisture coming from the atmosphere also it absorbs but here you are moisture control is there.

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Then the other is a bunk silo the see the silo word for large storage it is there, in the last class we talked about the bunker now that sometimes it is the bunkers are also called a bunk silos. What are they? They are just trenches and then we give your productions and keep the material over here. It is a semi close type but the upper one you will be covering with turpulane and other then this bunker becomes a silo.

So that means that you are having its advantages it did hold a large capacity and it can be filled with conventional farm equipment that mainly this type of bunker silo is used in the agricultural sector and it offer a very faster unloading rate that is at whatever your other silo is there in this case you can do it very quicker unloading and it is inexpensive. There you can the cost of initial cost is very less.

So, it can it can shoot to the different operations in it is a large farms, a few hectares of land, they are doing their grains and all will have to be kept near the field and things this type of bunker silos are used. So that it require a greater in filling and packing. So, you are feeding arrangements and all will be little bit elaborate but it is a normally you will not go for a very small capacity. Silo can be designed for small capacity also.

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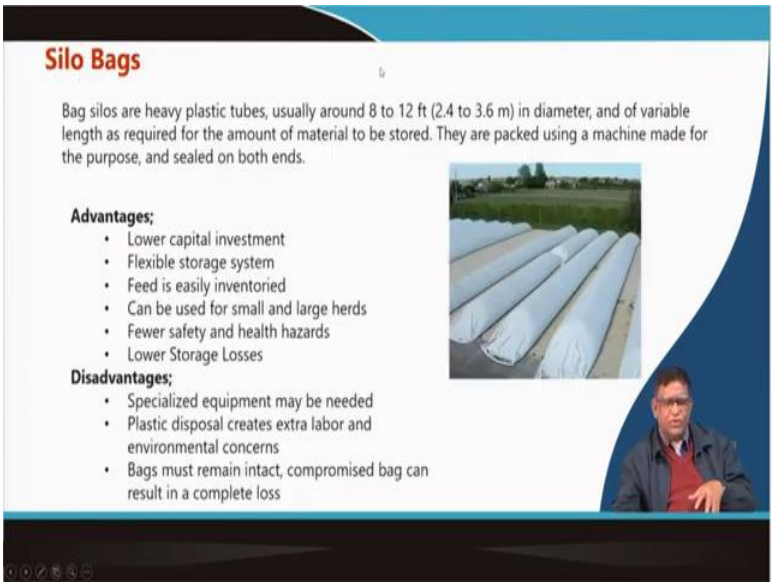

There are another thing which is interesting in the agricultural sector for the your bulk product in the rice and all you can use this silo bags. Many a time you are that storage can be improved by having the silo bags. Adding in Mangalore and all there are some Indian companies there this just manufacturing such type of big silo bags are there. So, there it can

be up to 3.6 meter diameter, big diameter big and they are very long big swear the material quite a good amount of material can be there.

You can think of different types of evacuation systems can be there. Here it is as big as it is not that metallic, concrete and most things are not there while storing over there. The investment compared to a construct a tower silo it is less. So, it can be depending on your the field if you are check you can store sometimes this if you are having a big cattle farm and the cow feeds, you are bringing it over there and you need to store it you can store it like that. So, depending on the way you apply, you will make this type of (()) (**26:41)**.

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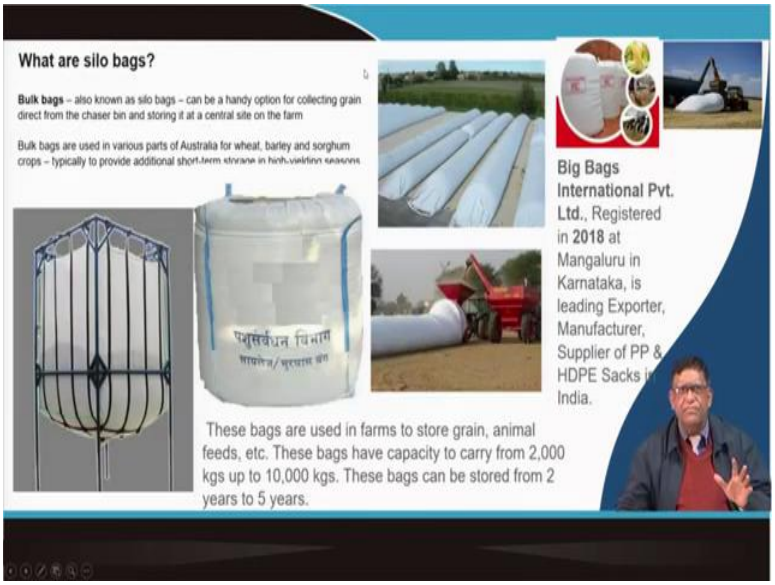

That silo bags it come in a very different way. You have got in our country, this agricultural sector, they have a used different type of silo bags. So, as a when we talk about the cold bulk storage, these are used but in our mineral sectors, such type of bags will not be used but okay. Some form of bag in a bag filters will temporarily it can resents but it is not a storage system which is used over here.

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So, other than that we have got that silage piles that silage means exactly your this fodder grass all are also bulk material. This when we talk is in general bulk material handling, we need to think of in the agricultural sector, there are a lot of this raw materials and then sometimes they even having a good calorific value by material. Because we have not systematically storing and systematically we are managing that, that is why it creates other problems.

I always tell that to when in your the environmental problem in Delhi because of the fodders being burned in the agricultural field of Haryana and Punjab. There if it is collected at the time of harvesting all the things and then maintain silage piles over here and this can be used as a raw material for your paper mill it can be used for long raw material for making a that is your granular bricks for granular fuel.

A fuel brick for household domestic conjunctions, it can also sometimes can be used for the cow pits for the different things can be used maybe for making now with Amazon and a this your Flipkart. Their online marketing has come up we need a more packaging such type of your some of the silage can be converted to cardboard and the packaging item manufacturing. So, this type of storage in the villages and all can give lead to a new market.

So, while you are developing your expertise in the bulk material handling, you can think of those alternative business and they are also you can take certain activity.

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But the another thing which you should start investigating is that you may have a failed silo failure can be a big problem that is your sometimes these failures may involve catastrophic. Sometimes it is just giving your operational problem. Because if it is not properly designed or if it is not properly erected. So, our next class, we will be discussing about some of the silo failure and how we can avoid that and how we should monitor it.

But here a lot of research needs will be there you will have to analyze, say for example that the how exactly it can become weaker how it can get different stress coming, even those who know about little bit of thermodynamics and all you know that during this during the daytime this they say that your there will be expansion of the metallic steel plates are steel shell over here. And during the night time they will get shrink.

Now, suppose we are having here 20,000 ton of material, when they will expand during the daytime that what will happen that the grains and things like that they will get a settlement but when in the night if they come that is you are giving a it will contract at the time will it be able to push the rice all the whole column up? No, but at that time that means this metal will be not differently stressed.

The stress is not released then ultimately they will be such things happening and it may become weaker and then sometimes there may be crack them up there may be other problems develop. So that is why, when you are storing a huge quantity of material and then if it fails, it may give you a catastrophic. All the things may collapse it may lead to some accidents

also. So that is why you need to put you should be interested to know that how they are designed.

What are the forces taken care of, say for example, at the top your conveyor belts are coming and giving a loading over here we are doing a 30 meter or a 50 meter silo. So, in that case that what is the wind speed at the top with the conveyor belt is coming and putting over there that conveyor belt will be giving on the stress and column structures which will be supporting the belt. And the belt is coming over there at that time that wind speed if it goes high.

Then there could be a problem in that and then if the conveyor belt start swinging then you will loading will not be proper, if lot of things may happen. So, the sources of the problems need to be seen.

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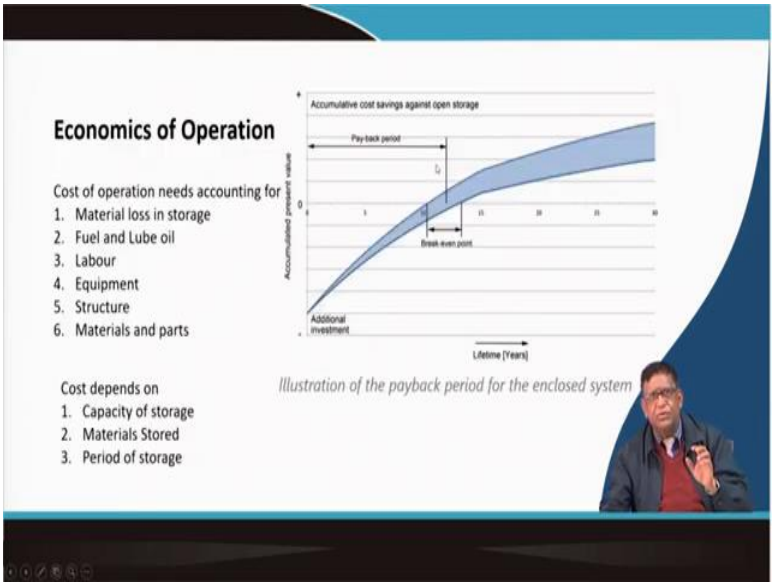

We will be discussing some failure, maybe in the next class. But on Economics of Operation is very very important. So, whenever you are studying bulk material handling, you are going to be a bulk material handling managers or a designer or a controller. So, all these functions are related to the economics. So, if a silo operation as a I have said that silo you are storing the constructions we can say it can be by structurally with reinforced or the metal or even the wood after constructing the operation is you have got the feeding you have good evacuation you have to control.

So, for this purpose, what you need to do your operations will have to be economic. So, when you know the operation, where are the cost centers involved need to be seen. Now, you will

be incurring costs that is if the material loss takes place, if you require more fuel and oil, if you require more labour, if you are some additional equipment need to be present, your structures need to be maintained materials and parts will have to be procured.

And that is why the whole cost will be depending on how much you are storing and then how long you will be storing and then what type of material you are storing. If the material can degrade also under the conditions. So, as a result that capital investment will be going so, if you are the that agricultural field is a permanent field which will be there running for another 50, 100 years people will be doing it.

There if you want to have a very good sophisticated system, after some years normally initial investment when you make your that return is not there of slowly the return will becoming an after some time you get your break even point and after that you get your whole thing as a coming as a profit. So, these type of analysis, whatever you have studied in your economics class, whatever you have studied in your business class, those things need to be put into and put in our bulk material handling and bulk material management by silo storage.

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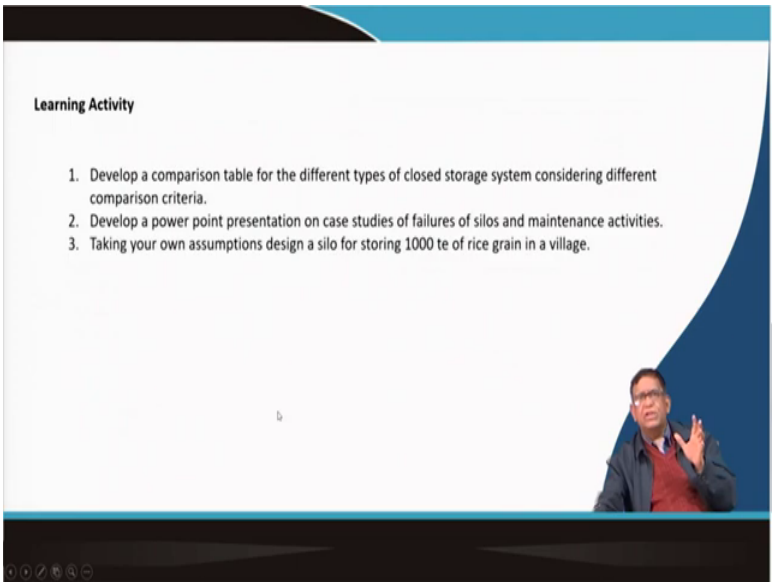

So, I request you, you take a develop a compression table for different types of closed storage system and considering different compression criteria. How on what basis you will be comparing whether you want a tower silo, whether you want a bunker, whether you want some bin or whether you in the open piles or you want to open storage. These are the different storage alternatives we have talked about. Now, what are the criteria on the basis of which you can compare them?

Cost is one but before that we will have to see that how much capacity it will be occur economic? How much environmental footprint it will be having? What is the operational problem it can give? What are the monitoring it will require? How many persons it will have? Those are the criteria, start thinking that whether the criteria will be depending on the time, depending on the capacity, depending on the location, depending on the material, depending on the climatic conditions, so many things.

So that your learning activity tried to find out that then develop a PowerPoint presentation on the case studies of failures, I request you please do an internet survey at this top researchers to find out in the recently last say 15 years you take, in the last 15 years, how many storage said accidents have taken place in the world's cold storage system.

That is you may look into the cold storage, you may look into the ore storage, you may look into the grain storage, you can look into the cement industry, you can look into the aluminum industry, you can look into the iron industry, you may look into the coal industry, different number of different student can look into a different industry. You can bring, say what are the failure or the that is your accident septic and present in the coal sector, someone can do in the agricultural sector then you will find that in a lot of things.

You bring number of PowerPoints, present it put it over there discuss it and put it on the YouTube let the people know and get it covered that is your learning activity. And now, I give another small problem which you have not that you can take up as a self learning activity. That is suppose, as I give you in a year 1000 ton of rice, a that a superstore one to keep. How will you exactly design that storage system? Or alternative to this you can take think of, say a shopkeeper, he sells say about 500 kilos of rice in a say a month.

So, for him, he need to store it then know where from his buying that he is getting at present by say different Gani bags it is coming and he is putting over there and doing handling it over there. Now, if you want a very good beautiful environmentally friendly aesthetically good looking that rice storage system in the rice shop you may think of that how the bins can be designed?

For there could be different type of rice basmati, if that is your boiled rice that raw rice, black rice and brown rice. And then they are putting you can just imagine put your imaginations and using that without going to the design calculations, a concept design you make it in draw works or in AutoCAD and whatever the engineering drawing platform you have learned in that you design this. So, these are the learning activities for this paper.

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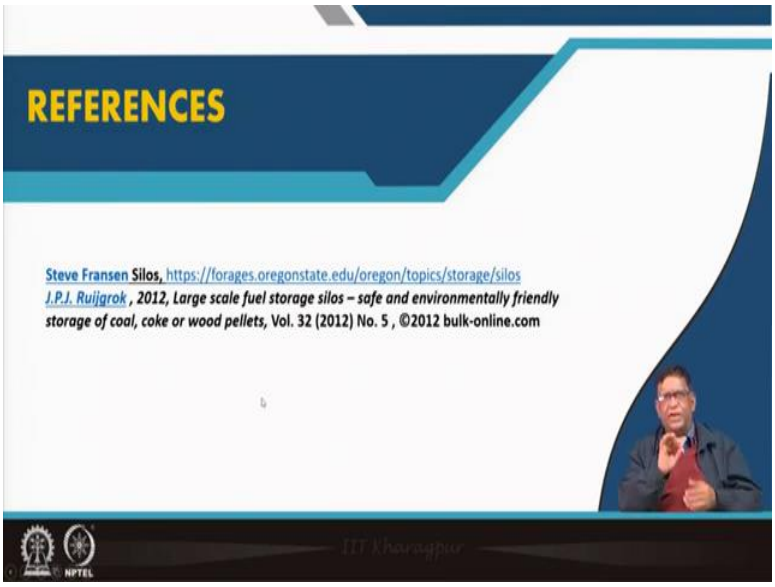

And you read some of the very good articles in the online these articles are available and then I think your learning will be proper.

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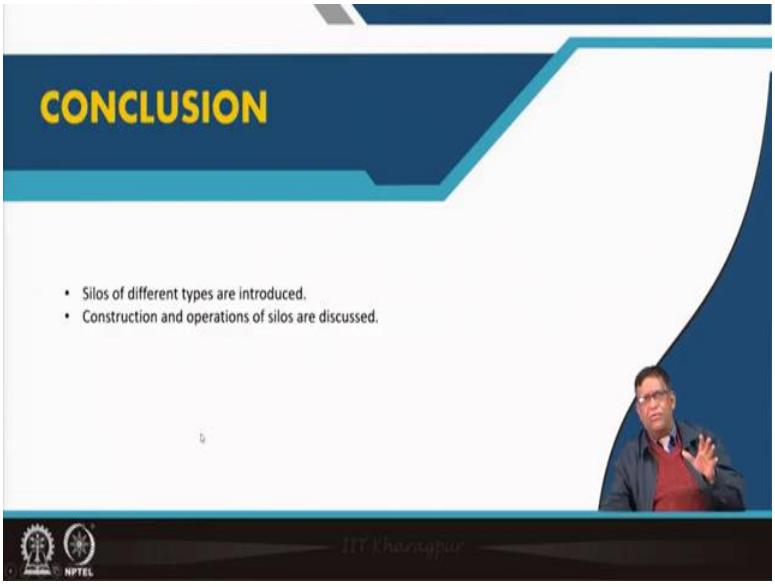

And what today we have discussed only the different types of silos have been introduced and the construction and operation of the silos are discussed. Briefly I have told about the failure.

And I have introduced to you how a learning activity can be taken up it is your job to do the work and enjoy learning. Thank you very much.