**Bulk Material Transport and Handling Systems**
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**Lecture – 23**
**Introduction to Bunker**

Welcome back. In our discussion of bin, bunker and silo in the last class, we introduced what are the storage bins and bunkers and silo where in our bulk material handling in different places we require this storage system. Now, today, we will be introducing to you another storage system called bunker. So, this word bunker you may be hearing that sometimes, the army use their bunkers for underground bunkers to stay there.

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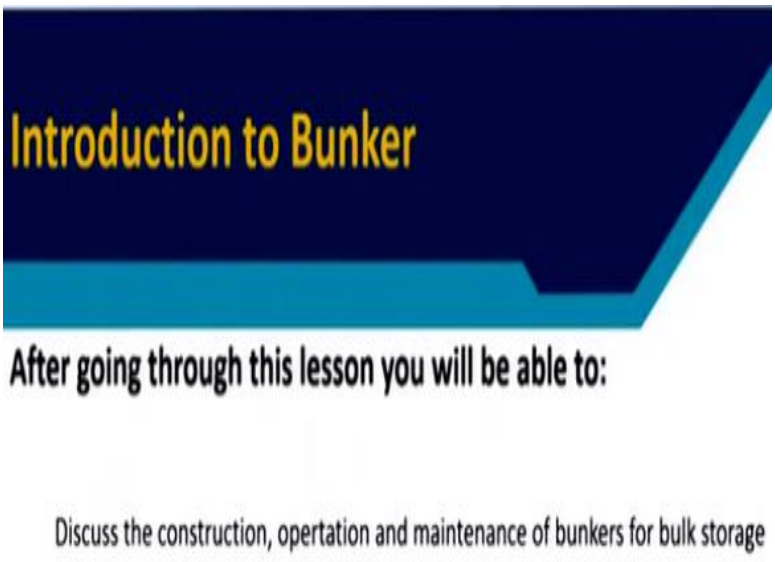


And then, also, you might have heard about this grain bunker, coal bunker, ore bunker, underground bunker, these are the different terminology we often hear. But, what a bunker is? And, how it is constructed? What are its functions? And, how will you maintain this for trouble free operations in the places where you are using? Those are the things will be discussed today.

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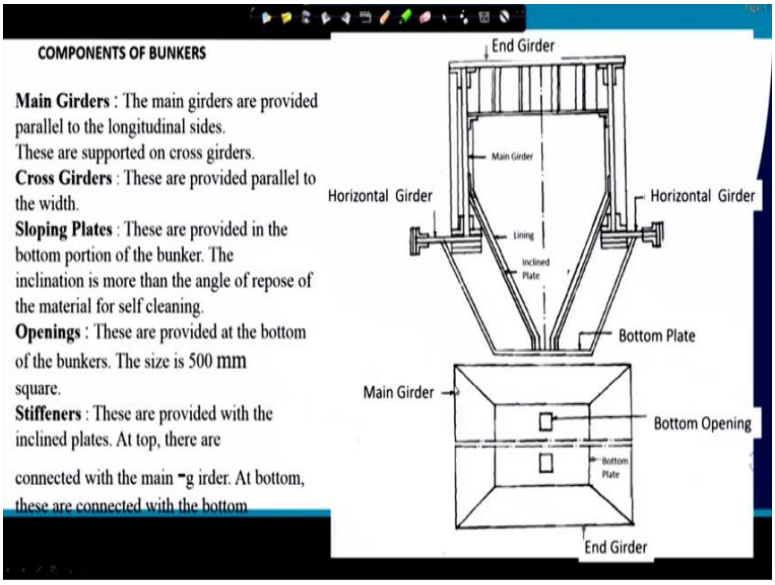


So, you know that a bunker it is a storage device. Only thing is that when you talked about the bin, bins are as a smaller storage. But, the bunkers are larger storage. And, that it can be a structure mounted. It can be on an elevated platform. Or, it can be on the ground. Or, it can be in the underground conditions. It can be constructed with different materials. But, basically, what is there? The main components you can find that there is a main girder.

That is a structural component is there. And, there are some cross girder by which it will be either giving a, that is to retain the material over there. And then, you will have to have a evacuation system. That is a receiving section. It will receive the material from the top. And, you will be evacuating either from the bottom. Or, sometimes, if you are having a flat ground mounted surface, you can use another reclaimer machine for collecting or reclaiming from the bunkers.

Now, that is you have girder in a bottom hopper portions. In most of the bunkers, you will find at the bottom. There will be a gate. And from there, it can be taken it out so that to give the structural strength of it. There could be stiffener. This is a general structure.

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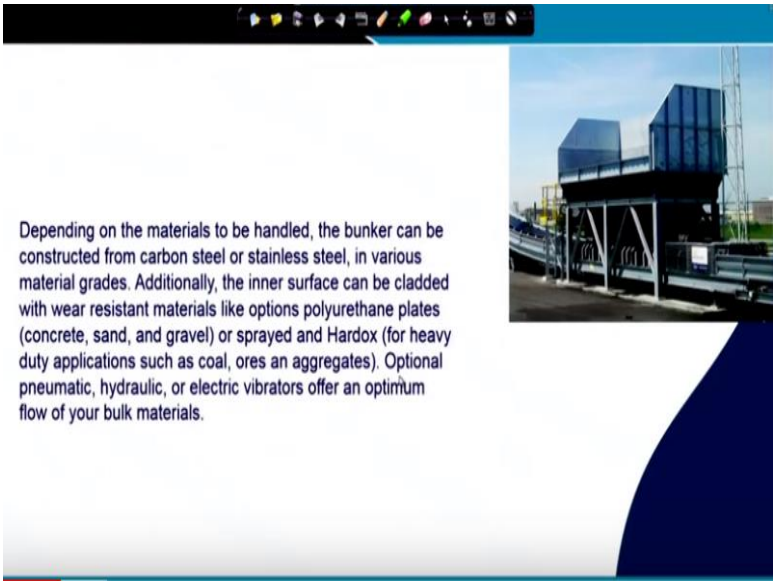


You can see here that a bunker is shown on this figure which is exactly can receive the material over here and from the bottom. It can discharge on a conveyor belt. Now, depending on the, that, what will be the strength? Depending on the capacity, it need to store. And then, that is how much pressure on it is coming. So, it can be made of high carbon steel, stainless steel or it can be made of different other materials.

In the old days, there are even wooden bunkers. And in some of the villages, some of the rice bunkers were only as a part of a room they convert to a rice granary they say. And, that is also a bunker. Now that since you can construct with a, that is, your, with soil only earthen bunker. That was available when we talk of some of our villages the way they keep their grain there will be an earthen bunker.

There could be with concrete bunker. So, these are there. And then, they could have different plastic materials for making this.

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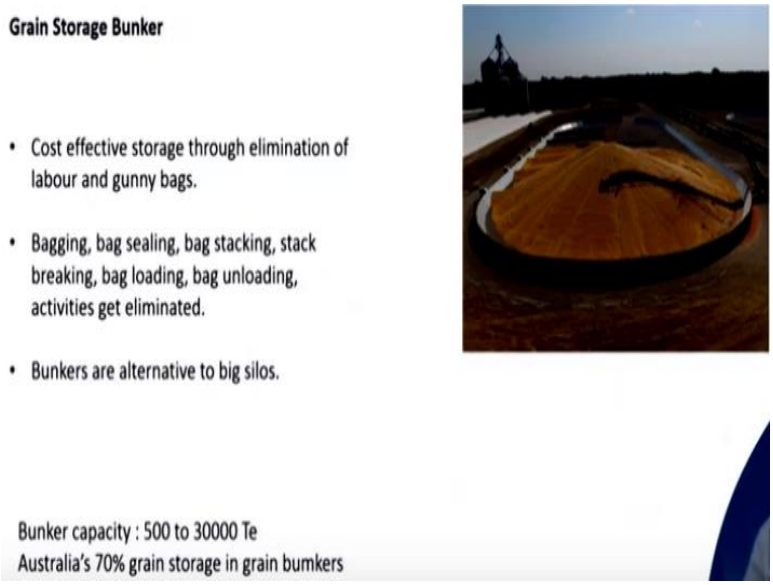


So, here, one when you are to store a large quantity of material you can use bunker. Now, let us talk about the grain storage. Have you ever seen any of the, our Food Corporation of India's storage places? Their godowns they say. You go to any godown you may see that there are lot of gunny bags that jute bags inside which this grains are kept. And, they are stacked over there.

You might have heard also in the past many places that some of the storage rice they get rotten because those are there in a gunny bags. And then, sometimes, these gunny bags are eaten away by this rodent mouse. They attack in the, this most of the, our storage site where the stacks of this bags of rice or grains are kept. You can often see there are the mice and these rats they get a lot of nuisance.

And also, in any of those the storages, you will find that a large number of workers unskilled workers need to work. And sometimes, for stacking and all, you might be seeing that lot of coolies they are just on the back they will be taking a big sack and then doing 1000s of tonnes of grains are stocked in our country like that. But, whereas, you can see that up to 500 to 30,000 tonne of grains can be stored in 1 bunker if it is properly designed and all.

By this, a, that grain storage bunker, if it is properly designed, it can save lot of money. It can save lot of wastage. And, it can create a beautiful working environment. And also, the business can be faster because the evacuation, reclaiming and sending this can be faster and the damage of the grains can also be stopped. So, in a basically, the cost effectiveness of a ground bunker may be because of the bagging bag.

When you make the bags of this gunny bags at that time you will have to seal the bag. You will have to that stack the bag. You will have to unloading the bags. Again, you will have to open it over there, loading onto the trucks and all. There are lot of things are there. So, I am telling you as a bulk material handling student, you can think of even at a smaller town where there is a rice market, where there is a mustard seed market, in those places, there could be a very good business development at a local level by developing this.

And, if you see now in Australia more than 70% grains are storaged in this bunkers. Now, let us see that, what does ground bunker is? How it is constructed? It is a very simple thing. You can see here. You have seen this bunker is there. You can see all around that inside is the material is kept. But, to keep these things, so, you are not having any big house building or anything you are keeping it over here. So, what is necessary to have such type of your bunker?

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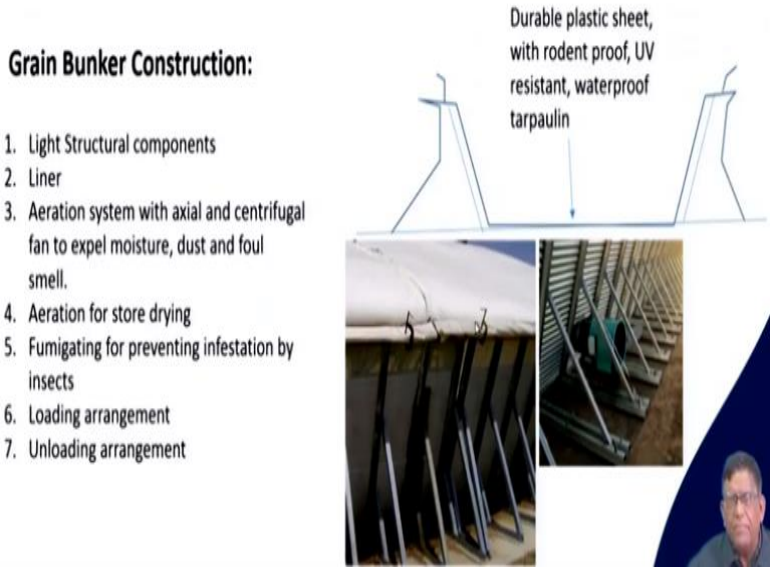


Your this structural part, this is exactly you can make such type of (()) (07:47) some alloy material some of this very light material, Aluminium oils can do, just type of there. You are making a structure depending on, how much capacity you want to do? How much area is there? And, what depth you want to keep the material? Depending on how we will be evacuating, you will have to decide those conditions.

And then, you need to see that what type of inside that you will have to give a liner. Normally, you give a durable plastic sheet liner so that this mouse and all they cannot come,

rodent free. And then, there you ultraviolet resistant because if you are keeping in open air and then if any radiations may come then you it should be waterproof. That tarpaulin will be used.

In the structure, you are keeping some that hook type of things over here at the corner so that when it is filled with grain you can see in this there is a tarpaulin cover is given that how you will be giving a tarpaulin cover and all you will have to consider at the time of designing it. Then, there could be even this is for aeration system. If you want to dry or keep that airtight if you want to fumigate it so that insects and all cannot go over there, lot of other arrangements depending on the requirement.

So, this aeration which can be by different type of fan it will remove the moisture. It will remove the dust. And also, sometimes, the foul smell and all if it comes, by keeping this type of aeration system in the bunker, it can be doing. And, you can see here this bunker is just mounted over the ground. And also, it can keep that sometimes when you collect the rice grains from the field it may be having lot of this your moisture content.

So, at that time, you can remove that moisture also by this. By aeration system, you can think of. The loading arrangement and unloading arrangements need to be taught. Now, these things instead of grain we can have such type of system in our, the mineral sector for coal bunker, for your iron ore bunker, for your, the beneficiated ore bunker, the washed coal bunker, like that different things can be made.

Even just when you are getting the ROM even that can be also thought of putting in a bunker instead of that is sometimes we have we are already using some open storage system near the railway where the railway yard is there you are stacking over there. If we come with a design of bunker with a drying facility then the moisture content in the iron ore or in coal which can be reduced by.

Sometimes, if it is going it is in rainy season iron ore going with a 30% to 50% moisture content means it gives a lot of load into the, that your locomotive whenever railway transport a lot of energy or fuel is being consumed for taking those moisture. If you can dry it by putting some energy over here, then, your, the quality of the material which will be received in the blast furnace will be much better.

So, there are system can be organized in a bunker if it is properly designed then keeping it just only as a open storage. I hope you have understood what is a construction of it.

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Now, you have constructed that you can see in this figure that there is this ground bunker has been designed and inside that this grains are kept. To keep it, how will you stake it? Your stacker, this is a portable conveyor stacker is there. And, you can see here the trucks are bringing the grain from the farms and the farmers' places. This is here. They are coming. And then, they will be unloading over here.

After they unload, they will be going through this receiving hopper here. And from there, it will go to the conveyor. And this conveyor can stack. Now, this conveyor which is mounted on a crawler mounted system which can travel along this line along the bunker. And, by that way, it can fill the bunker. This discharge boom it can be a telescopic one so that you can fully extend and give the (()) (12:20) provide the material onto this so.

A bunker stacker it is another better material handling equipment. If you can think of that in India if the Food Corporation of India takes a decision that they will be having a proper that bulk storage system instead of the grain will be kept in a unit storage it can lead to a, at least a few 100 of crores of business. Because, then, manufacturing of such type of devices, manufacturing of such type of platforms.

And, a small scale in every rural agricultural markets that could be coming up which can generate your a large number of jobs which will be much more than the job which will be eliminated by giving very tedious labor prone that jobs of carrying the bags on the back and all. And, those workers their earning and there you are thinking that they are earning because of the system and if we bring this mechanizations there job may go.

But, the ultimate benefit will be they will be getting much better jobs in this new system. So, that is why the bulk material handling can create a new economy.

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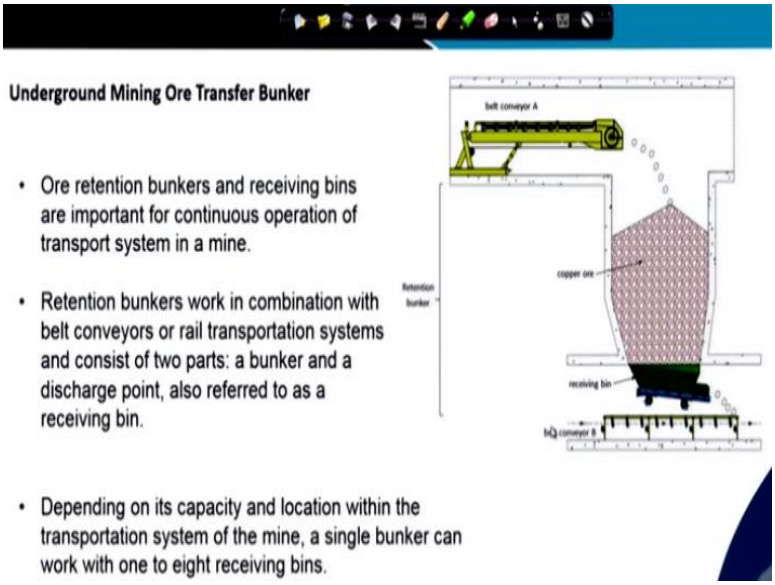


That same thing this, your, the, when we do in underground mining there is one problem. That is you will have to take out the material from there by conveyor belt or by this your winder. And, there is a limited capacity. And then, when you are doing the mining operations that in that there will be blasting and then there will be that you are collecting the material and then putting it that all the time continuously there it may not come over there.

So, but, your supplier at where you are giving at the surface if you can maintain a continuous flow of material your that to whomever you are supplying they will be in a better position. For that, a temporary storage is necessary inside the mines. That is in underground there. And, there we have this underground bunker system. As you can see in this diagram that from the face or that where from the ore this mined from there it is bringing by conveyor belt.

And, inside this whole structure is the structure is formed within inside the mines by removing the material. And there you give the liner and all with the concrete or steel or by

timber. And then, you are keeping the material at the below you keep a feeder. That is a belt feeder because it is going to get another conveyor belt. This conveyor belt will take the material either up to the surface or to a skip that is where the skip will be loaded.

And, the skip will be raised by the winder from the underground mine. So, this type of system of bunker could be there in a row. There could be 8 such bunkers could be there by 8 districts the material may come up to here. So, that is what in a bunker system it could be a single evacuation point bunker or it could be number of multiple evacuation bunker. Such bunkers inside the house inside a plant also a big bunker can be there and where number of places this material will be coming and it could be taken out.

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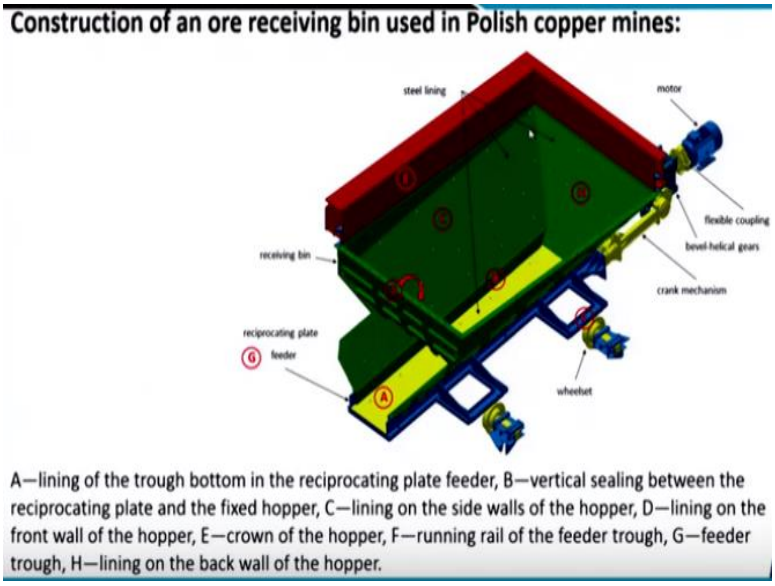


So, when you see such type of, in a bunker, basically, what is there in the construction, you can see here that just you are having a hopper portions. You can see the outside these at the side walls. And then, you can find that there will be a lined top this that first one here we are having a line trough which can be reciprocating like this so that it can load the material by opening the gate to the next evacuation level. Then, there will be a vertical ceiling.

That means it will not allow the, that is you are keeping it in a sealed form so that this can be kept separated and then there will be lining inside the wall and then the lining in the front wall of the upper and that in the crown of the upper. Different lining is given so that this material can smoothly go out of it. Then, there will be running rail on which that it will be giving the feeder.

And, that whole thing is supported with the motor so that the whole control of this your reciprocating trough and all can be done by this mechanized means. So, last, like this a mechanized bunker it can be placed inside the mines or it can be there also in a constructed.

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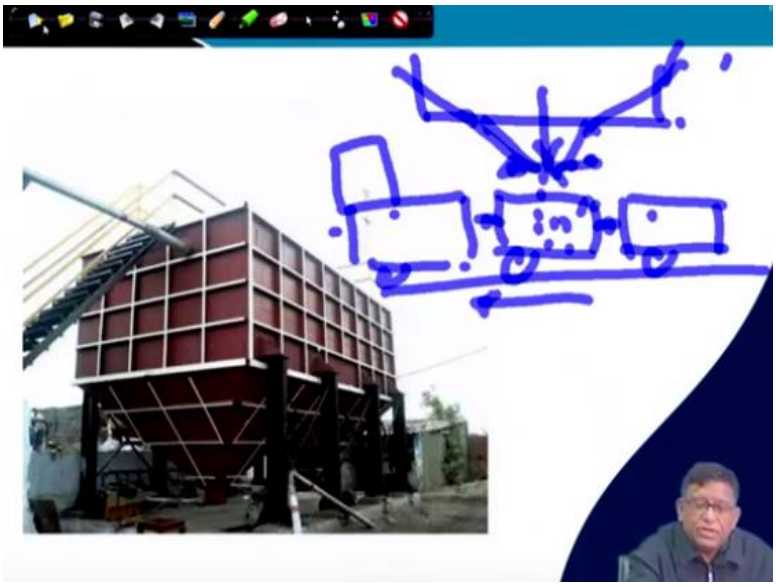

So, in a surface, you can see here. This is a bunker where you can see that 2 points of evacuation is that these 2 hopper portions you can see. And then, it can be that say for inspections and all, you can go over here. Or, you can use a conveyor belt to load over here. There are different types of design and arrangements are available by different designer. They design in a different way depending on the situations.

So, what we are having a bunker it can be as you have seen in the first one that it can be on the ground as you have seen in the, that is your grain bunker. It can be there in the underground. You have seen by underground. Evacuating or mining and excavating the rock you create a structure. And then, you give the liner and there you keep the material and make the arrangements for taking up.

And, in that, you can fit an, externally fitted structure and that will become a bunker in the underground. And, this is an elevated structure. Here, you can see that these are all steel girder or stilt column or it could be even a reinforced concrete column over which you are having this platform. And, this, your vertical portion this will be depending on what capacity you will have to do.

So, here, we are having this rectangular portion. But, below here, there exactly 2 parts, compartmentalized so that you can evacuate over here. Now, depending on that where it is evacuated, you can have the gate system at this bottom. In some places, there could be a bunker from where it will be just loading onto the, your truck. And then, the truck will be coming over here. When truck is placed at that time this here the gate will open and it will go.

Even sometime, such type of bunkers can be made over the rail line. If the railway line is here below, the railway wagons are getting placed below the bunker and then the bunker gate will open. Material will fall onto the railway wagon. And then, the locomotive will go. This is which silo I will be telling next class. I will be talking about silo with silo unloading, bunker iron loading. Here, exactly that the wagon loading can be done.

Now, in normally, we have discussed in our material handling when it is there, from the ROM from the run-of-mine which is coming while loading on to the, your railway wagon from the side from the stockpile by front end loader they were loading. By that, it requires a long time to make a rake of say 70 wagons or 80 wagons. It will take a longer time. But, here, if you are keeping the material from the mines when it if you bring it by conveyor belt and put it over here and then that wagon the locomotive will come and will travel below this line.

Like that, it will go and that the speed of the railway that rail wagons below this is so adjusted that at that speed when the wagon will stand just over here that your gate will open. Material will start falling at a rate that rate of material falling and the rate of the advancement of the wagon are so adjusted as soon as the wagon come up to the end. That is your, it get filled and momentarily your gate get closed because from one wagon to the next wagon there is a gap.

During that gap, no material will flow. Then, the wagon will go a little bit faster. Then, it will happen. That basically, what is happening over there is suppose your, this wagons are here, now these wagons they are coupled in between. Now, here, there you are having, suppose, this is your locomotive and they are just going over this track. Now, your, this bunker which is over here. And, it has got its bunker upper portions here.

So, now, you can have this bunker unloading is taking place. Now, this gate which could be it will start falling material will start coming over here. As soon as it will go advancing in this direction, this point comes this get closed. And again, it goes up, this next wagon will be

coming over here, material will start flow and will go. So, that means here comes the automation.

That is exactly when the when your with the use of such type of bunkers, you can make this your loading and that your bunker get operating automated. For that, you will have to have the sensors that when your wagon is just getting below and when you will be putting it. Now, at that time, how it will be adjusted? In our silo class also, we will discuss about it. But, at this point, please note that the operation of a bunker is very important for getting these things your flow rate.

Now, as what I told you the other day that is there is a problem of the flow. That means the arc formation or for this your, that right hauling and all that may happen at your these portions. Here, you may have this exactly, your, you may have the right hauling over here or the arc or bridging then the material will not flow. So, in that type of situation, your, just only this bunker will not do. There will have to use some flow aid inside.

There you can think of if your material is sticky, high moisture content, prone to formation of bridge, then what type of additional technological or engineering arrangements you will be making in that point of loading is very important. You may have a vibrator over here. We may have a chain conveyor over here to just all the time keeping the material moving and loading and evacuating.

So, those are the things where lots of innovations go every year. And, you need to see about that condition.

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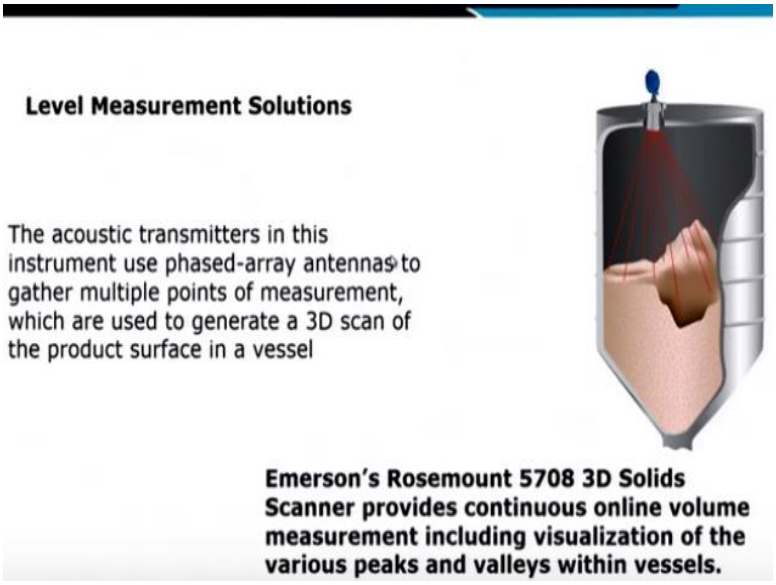


Now, as I was telling that if you are doing this loading and then your material is coming and getting filled into the bunker. If it get over filled, at that time, if you do not say or give a message to the incoming material flow, if it is by conveyor, then that conveyor need to be stopped along with that all the subsequent conveyor will have to be stopped. So, to do that, we need to exactly monitor how the bunker is getting filled up.

This is again a place of our where the mechatronics is used in our all and the instrumentation is used. One, there are many alternatives could be there. And, I hope some of you will be doing a project work. During, your, as a requirement of your graduation, you can think of what type of this sensors can be there. And then, from there, how the signal will be going? There are something like a acoustic sensors.

They just take the, that they emit sound wave and from that they reflect and they find out at what is the level? And, how their shape is coming? How much is getting over there? You can use by laser beam. You can use by different method. Or, you can say you can think of say from here you have it you can have a beam coming. And then, in this side, you can have a receiver beam.

If this material is coming and then rising up to this much, there will be an obstruction. As soon as this obstruction comes you can give the signal to the conveyor belt to stop. So, such type of things you will have to think of there.

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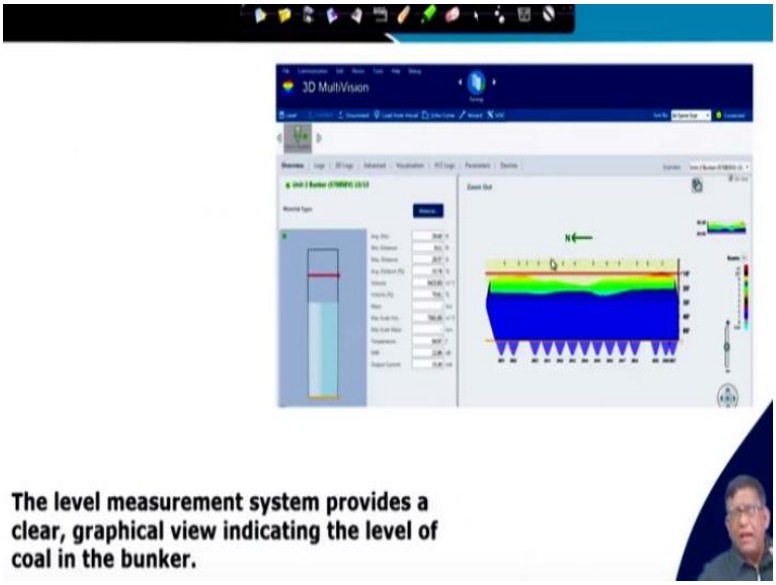


And once, these are the different a big bunker with number of entry point out. Then, with a monitoring system, with an acoustic system, they have developed a 3D visualization of the systems. And, they find out where the level is there. And then, they put these things and develop in a computer. You can monitor. And, sitting in your control room, you can tell that which conveyor should now stop or which conveyor will have to be bringing the material over here.

So, this level measurement system provides a clear graphical view indicating the level of coal in the bunker. In a coal bunker, in any, say, coke oven plant, in, say, for example, any carbide plant, in any anywhere with thermal power stations your where the coal stock is coal is going and directly going to the boiler and the before going to the boiler you need to maintain the stock level properly.

And, these are the places where already technology has got implemented. You should try to see those case studies as well as try to imagine how you can get a new systems developed for this.

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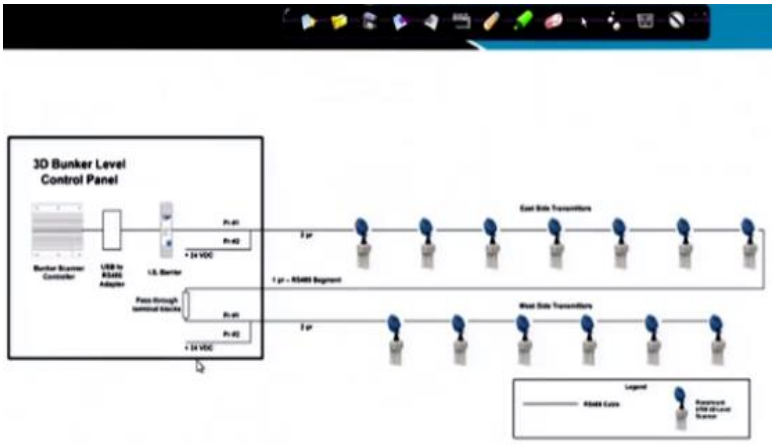


**This system architecture diagram shows the connections between the 13 level transmitters and the bunker scanner controller.**

The other thing is that they are using this, the video monitoring. In your whole system where your 3D bunker control panel, they have a 3 dimensionally they get the things. They will be having a number of transmitters. That is they will be taking the video of each and everything. What is going on inside? How that moving and all? And, on the basis of that, they give a real life realistic visualization of whatever is happening.

And, that once you are capturing the information, you can transmit anywhere. Now, if you are having a fiber optics line, it will be taking over there even by transmission wirelessly also. That is to be done. So, these are the developments that you must look into.

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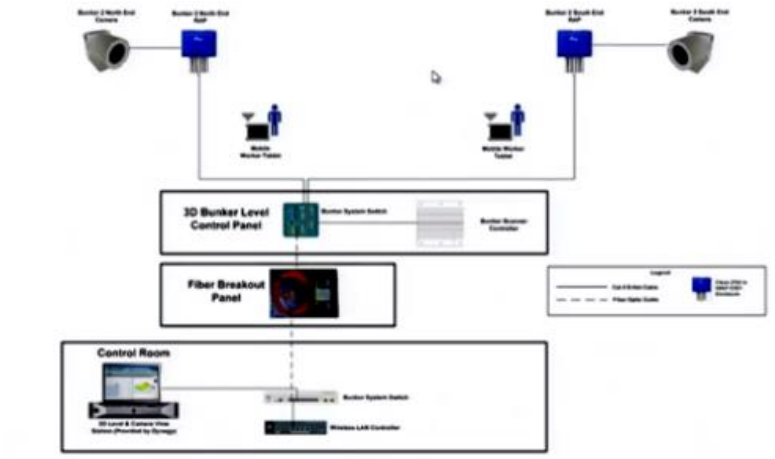


**This diagram depicts the overall system architecture for the upgraded bunker room control and monitoring system.**

And there, how the overall system architecture work. Here, it is saying that you are having the bunker camera and then you are having this your different that your sensing devices and

then the worker they have got their own terminal and then whatever the bunker control panel they will be seeing how much material over there. And, they observe if that how the from the bank bunker how the material is taken out.

And then, the real situation whatever is happening is given into the control room. This is just a year such type of systems are commercially available. But, for your learning purposes, you should see that in which way such type of information if it is obtained, what type of software you will be can develop? And, how you can visualize? That is where the data science is being utilized here.

Now, today, this machine learning, artificial intelligence, they are all being applied in this sector of our bulk material handling.

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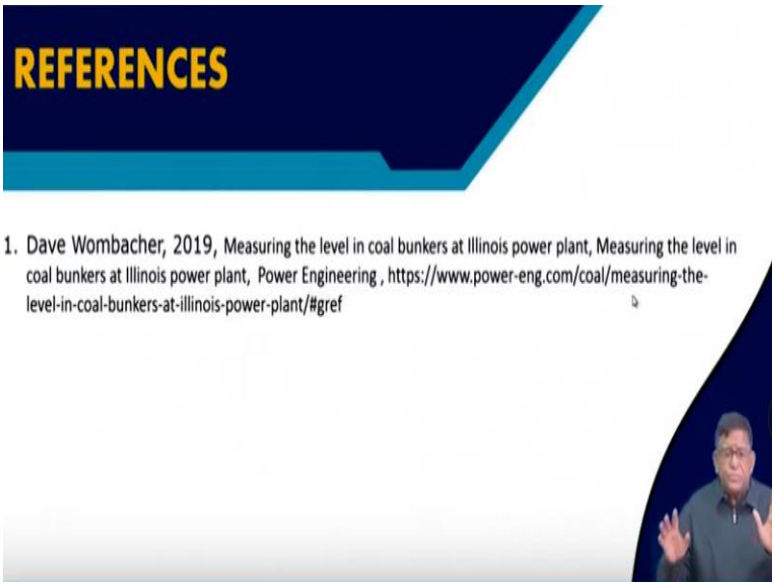


So, you can go through number of, this is a good article. You can see there where the measuring of coal bunkers are done. You make a habit of looking into the latest development. And, on the basis, you can create that what a bunker how the different application is monitored.

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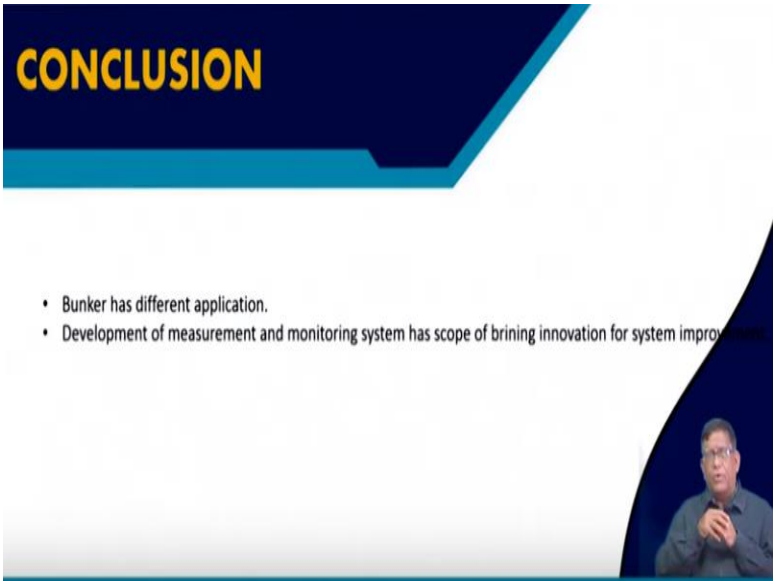


Again, I repeat the word. You must measure. And, if you measure you know what to be controlled. And then, when you control, your operation becomes smooth. Otherwise, a controllers operation has got no meaning. So, what today you have learnt that there are different types of bunkers that ground bunker, structural supported bunker and underground bunker.

They can be constructed differently by different material depending on the purpose. And, there are this, your, from the bunker, you will have to take it out. You can stack it by using bunker stacker. There are different types of bunker stackers are there. And also, you can reclaim by taking evacuating onto a railway wagon from by or in a control or in an automated manner or sometimes you can reclaim by additional arrangements.

Say, for example, if a ship bunker when it comes, a ship unloader they will be taking stacking material with a bucket chain type of ship unloaders are used for bunker evacuation. There could be even other reclaimers which you have studied in a bulk open storage reclaimer. A modified version of the open storage reclaimer are also can be used in a bunkers of type. So, there are also some bunkers which can be totally concrete.

That bunker you have seen as a steel structure, stilt or reinforced structure of bunker. But, sometimes, it could be totally a reinforced concrete bunkers also. So, I hope you have now learned, what is bunker? And, we will be continuing our discussions next time with silo and silo controls, thank you very much.