Mining Machinery
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Module - 05
Lecture - 25
Surface Mining Machinery: Machinery for Continuous Excavation: Dredger

We will be discussing today on the, another type of machines which are used particularly for underwater mining. So, you may be hearing of that many times we do the sand mining nowadays sand has become so important. And sometimes you might have heard that some non mining activities like river management there also you might have heard this machines name that is called Dredger.

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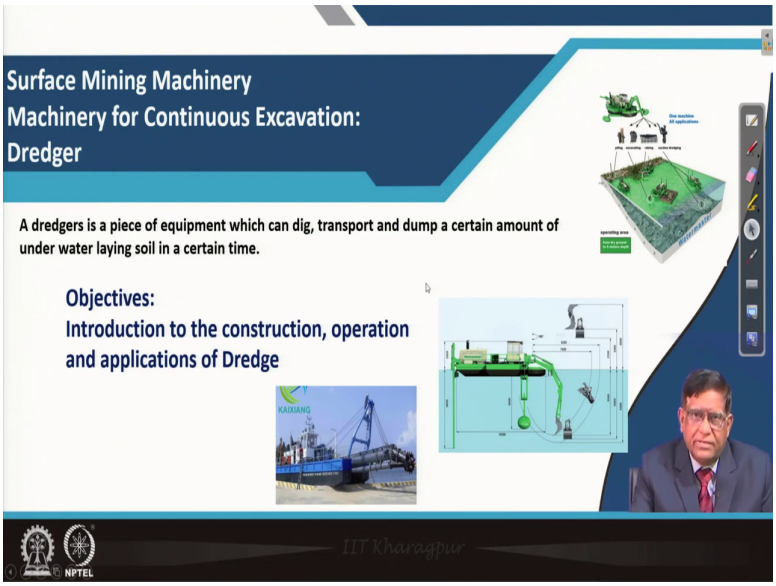

Now, today we will be discussing this dredger which is a piece of equipment which can dig, transport, dump a certain amount of underwater laying soil in a certain time; that means, this machine dredging machine it is main job is if there is a some rock surface or shell surface or anything is there which is below water it will be cutting from there.

It may be two things, it can be sitting on the bank of the river on solid ground and then doing the excavations from the water or it can be floating on the water and then it is doing the excavations, but at that time while it is while it is moving at that time also doing the excavations or it is stationary and doing the excavations but if it is on water it will have to be anchor properly.

And then this is also a dredging operation if there is a undersea mining; there is another area of mining, but whether it will be not purely a surface mining but it comes under that is a all together different subjects that is our undersea mining. In this we will not be discussing the all detailed machinery of undersea mining.

But if you are interested you can study that how the Nautilus Company they have been doing in say Misima Basin of Papua New Guinea they are doing that undersea mining by some ship developed in Belgium. So, there are lot of developments have taken place in the last 10 15 years in that line.

But today we will be discussing this dredge that what are their construction, operations and how they are applied. In this figure you can see a dredging which is having a just like bucket type of things, it is taking the underwater mineral cutting it over here. You can see that there could be different type of tools which can be attached here an hydraulically.

You can dredge or you can cut the underwater materials or we can have in this figure you can see we are having a cutter head and then with that it will be sucking the material and then through a hydraulic transport it will go over here. So, there are lot of things are there.

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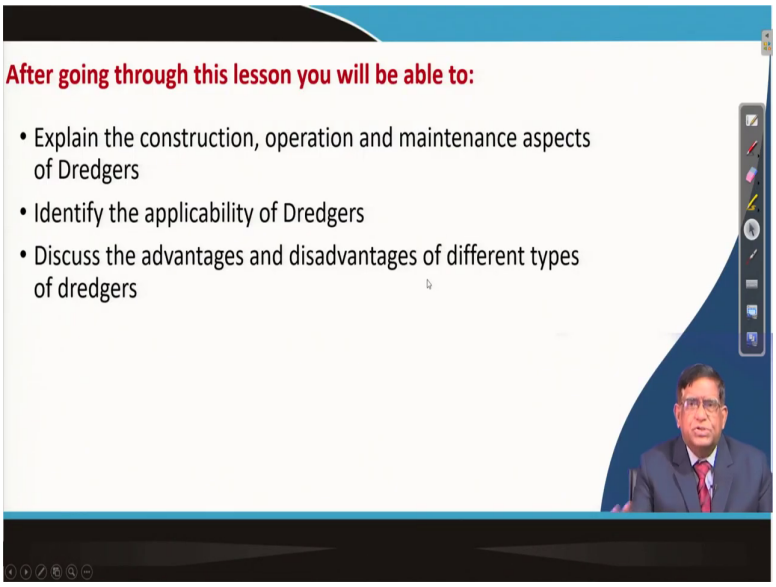

These machines were very much used while the Suez Canal was formed at that time. So, it is also a old machine used for underwater excavations. So, after going through this lecture you should be able to explain the construction, operation and maintenance aspects of this dredge machines and also identify the applicability where you apply, for what purposes and what are its advantages and disadvantages of different types of dredge you can discuss over there.

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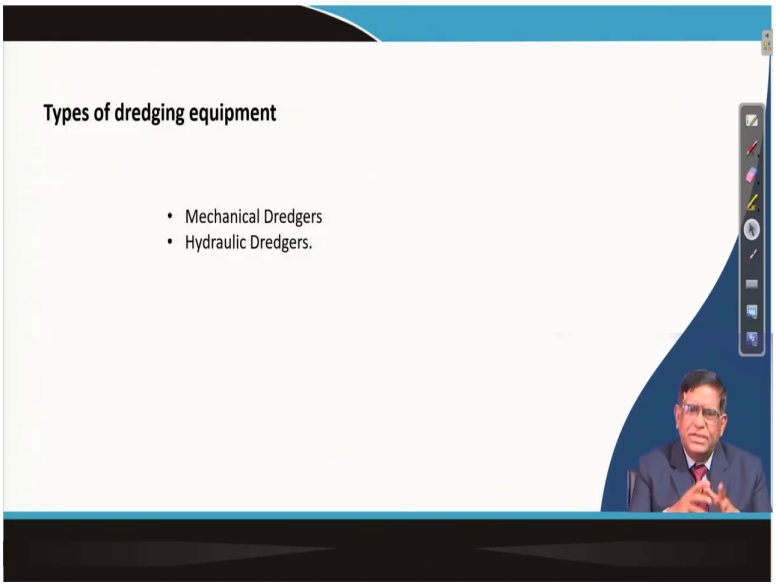

So, with this objective let us see if you talk about the type of this dredging machine there are two main types. One is that mechanical dredger another is hydraulic dredger.

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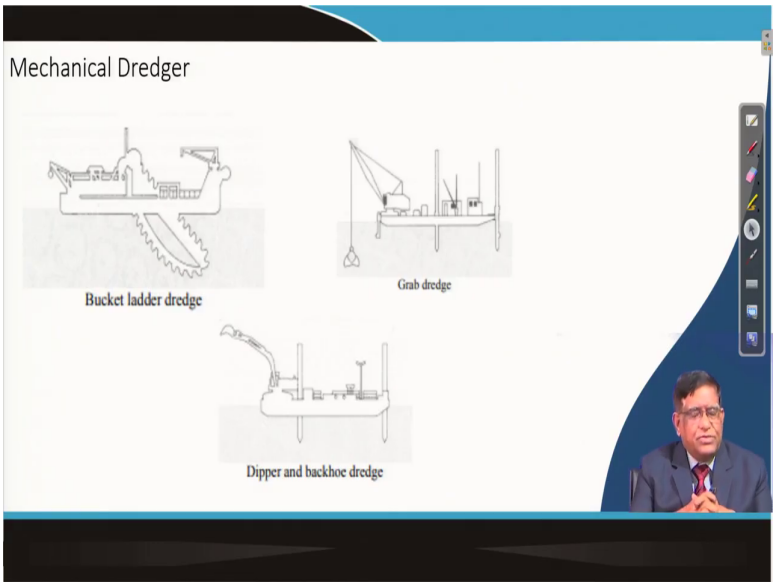

Now, if you think of this mechanical dredger it has got the bucket ladder dredges or it has got grab dredge and dipper and backhoe dredge that the photographs which I show in the first slide. It has a backhoe dredge or it can be a grab dredge. Sometimes it is also this type of this grab bucket excavators are used even its from some ship unloading they use this type of machines.

And this bucket ladder dredge is similar to your bucket chain and excavator whatever we have studied in the bucket chain excavator that can be used and that is there.

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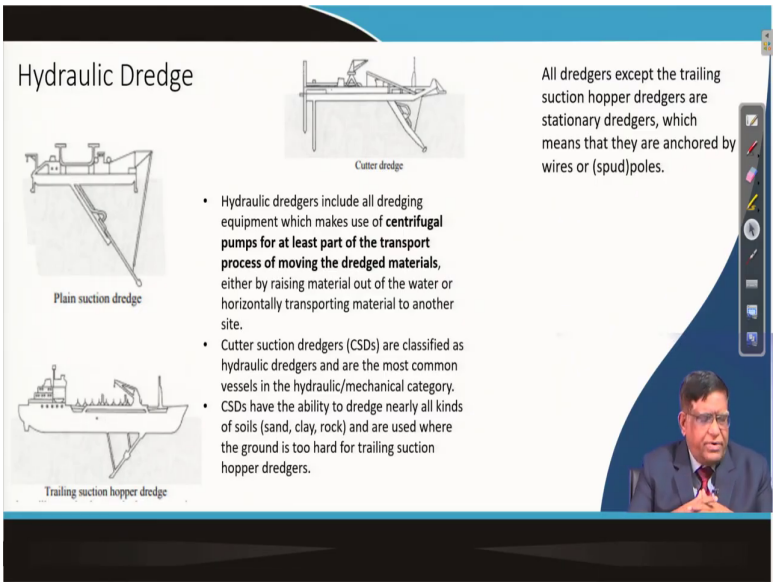

But in the dredging operations many of them they use the hydraulic dredge. These hydraulic dredge which can be a plain suction dredge from the below underwater, the material is exactly sucking through this and then through a pipeline as a slurry form and it is taking over there.

Then you can of course, from the slurry you can separate by filtering the solid part and the liquid part can be removed that is there and there is a suction hopper dredge on a ship the dredging units are attached with that. There is a cutter dredge, this is very commonly used they have got a cutter head suction dredge.

Now, they hydraulic dredges they include dredging equipment that makes use of the centrifugal pumps if it is a slurry which is to be sucked. So, that is where they will be exactly

making a pumping from the bottom and that is done by centrifugal pumps and then the material will be transported through a pipeline.

So, there is a cutter suction dredge they are exactly called hydraulic dredge and they are working there is a in a mechanical hydraulic category of machines and they have got the capability of cutting in all type of soils that is your sand, clay or rock. Because the cutter head it will be loosening mechanically loosening the rock.

If it is hard rock is also there that will get cut and they form chips and then chips with water they will formed a slurry and a pump is a slurry pump which can take everything over there and pump through the pipeline to take it that and then it will be transported whether they will be stored in that barge in the ship on which this dredge is mounted or from there it can be through a pipeline transported to the rest of the wherever you will be doing the processing of that.

So, these are normally when it is working on a, the on a water it will be made stationary, during the working it will be made stationary. It can be anchored or sometimes there will be some spuds on which it will be mounted over there.

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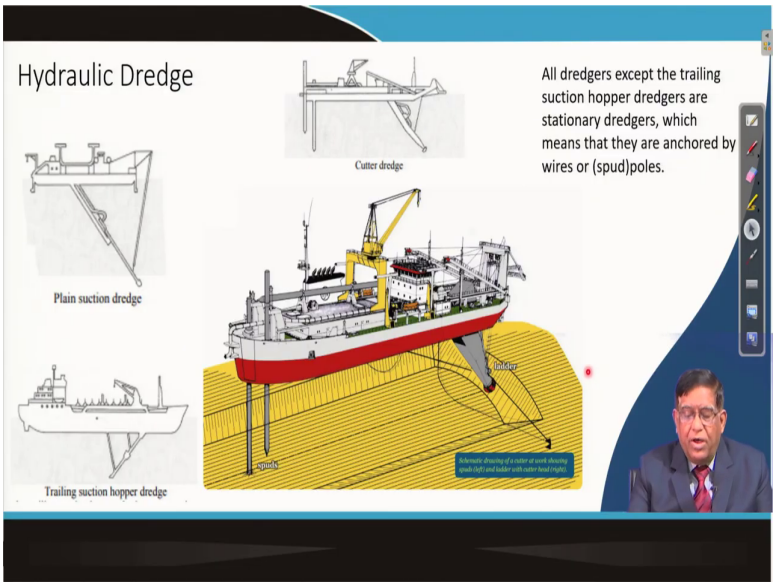

So, there is a different type of this dredges are available. This photographs give you a picture how a, it you can see a shape on which you are having a ladder at the bottom of it we are having the cutting head here. Now, this cutting head exactly you can see here this cutting head will be loosening the rock mass and it will be this ladder it can swing between this range so; that means, that this much part it will be cutting.

Now, there has a spud by which it will be anchored so; that means, this machines during the cutting it is getting stationary and then again after that whatever the reach of this can exactly this ladder can moved this way and that way and this can give a rotation this way and that way. So, by standing in one positions, it can cut one block.

So, after that block is cut this spud will be removed and then the ship will be moving forward and then it will cut like that. This cut material from here it will be pumped and it will be

brought to the barge where this is there and there it will be having a filter unit when the material will be filt, filtering and all.

So, now there is a crane for the maintenance and other operations which are going on. So, like that exactly a dredge or dredging machines work which is I am telling that operation is exactly not a real surface mining it is a underwater mining, but definitely it is not an underground mining. So, that is why this machinery is kept under the category of continuous surface mining machinery.

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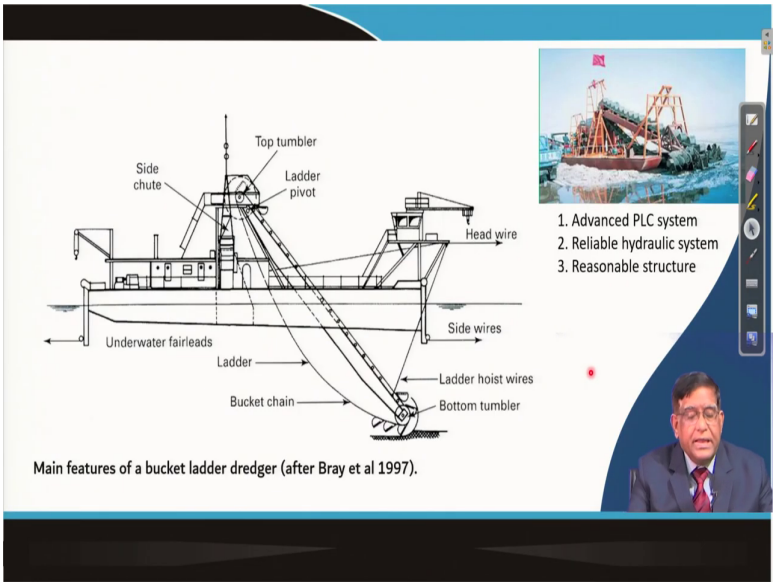

Now, you can see here what is this exactly a main features of a, that is your bucket ladder dredger. This is a ladder on which now this is a chain mounted just like a bucket chain excavator you have got this buckets will be cutting the bucket may be having the teeth and

collecting the material. And then the material be coming over here and then it will be moving just like your I told you previously.

So, there is a programmable logic controllers units are there, a hydraulic systems are there and a structure they make the main core of the machines.

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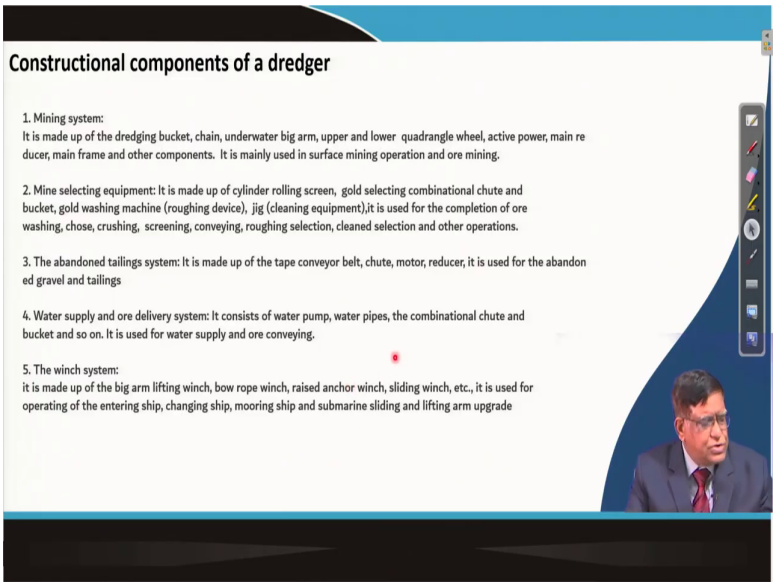

Now, the constructional components wise this machines also will be having a mining system; that means, as you have seen it will be having a ladder and the cutter head that will be doing a mining operations and then this will be exactly that a what type of mineral how they will be cutting depending on the.

So, you will have to select the equipment and there the mining means you will have to separate it out after the cut material is brought to the ship or that where this dredge is there

you can you may require to crush them to grind it. So, that really the gold or copper what is there to find out because they will be mixing in somewhere hiding in between some rock.

So, you will have to crush and grind and then you will have to beneficiate that is you will have to remove the gangue material and then the main mineralized particle they will be poured and then they will be stored over there and can be transported to another ship or barge who will be taking the material to the shore or that where that will have to be used.

Now, the tailings; that means, on that ship itself when you are dredging the material say the mainly the in south Pacific Ocean you have got lot of the shallow depth and also there are lot of copper and gold rich that is a sea beds are there that the seabed mining is done by this type of dredging.

And then when they process it say sometimes for the separating the gold you have that a process in which you may use cyanide, you may use mercury and those contaminated things along with the tailings their disposal is a big problem.

Sometimes they can stored and they can be taken out somewhere or they will be just discarded into the sea, but for discarding that again there will have to be a chute or a there will be taking a small sort conveyor belt or through slurry pump through a pipe it will be transported over there.

So, depending on the situations the components of that systems will have to be there. Now, there will be also that your the water which will be taken from the underwater it will be working and then the they will make the slurry form and then it will be moving. So, that water and after the deslurifications that water which is coming that will be again discarded over there and then there will be also in the machine some winch systems are there.

So, that winch will be controlling that you are raising and lowering of the ladder and also that is your the ship mooring operations many times that will be there that is why in the machines

you have seen there will be a overhead crane also. So, that maintenance other things movement can be done.

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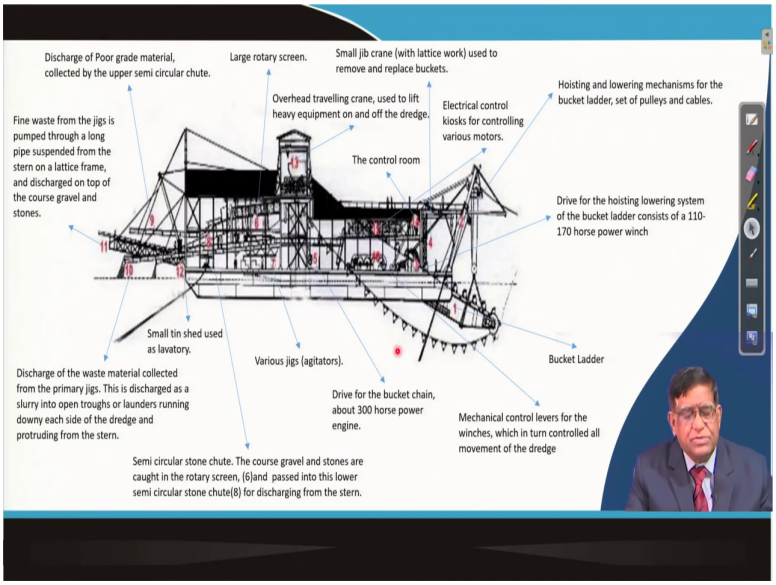

Now, let us see in a this type of a bucket ladder dredge see the components how it is there. The main bucket ladder, this is the ladder on which this chain is there on which the buckets are mounted this buckets are cutting and then carrying the material over here. Now, then you can see the next component here a hoisting and lowering mechanism for the bucket ladder.

So, this bucket ladder is hoisted and lowered by either rope winch or a hydraulic systems are here. Then there is a drive for the hoisting and lowering system; that means, your this hoisting and lowering will have to be done by drive whether you have to take the power from electric motor or for the diesel engines about 110 to 170 hp engine will have to be here diesel engines from there you make this full bucket to raise and lower.

Then there will be a small some small crane here. So, that the bucket replacements take out the bucket to put somewhere they will have to carry that maintenance purposes a crane operation is there. And there is a control room that control room will be working over here.

Then there is a drive for the bucket chain, this bucket chain this will have to be driven. So, there is a drive motor here which will be running this sprocket on which this chain will be moving and then the collecting the material and transporting the material will take place and then there are the for the processing purposes there are different jigs are there in the machine itself.

So, that the mineral can be processed over there and there is a screen rotary large rotary screen by which this material mineral processing will be carried out ok. There is also one overhead crane here for heavy equipment lifting and all purposes. And then you can see that there is a stone chute by which the material will be loaded to a, that for the discharge purposes.

So, that for the discharge of the waste material is collected from this jigs and then they will be exactly given the. So, that they will be discarded to the sea or it can be taken out away from that these are the things you can see the discharge of the material taking place and a the fine waste of the jig is also pump through a long pipe that is also given over here. So, thus a machine has got various components.

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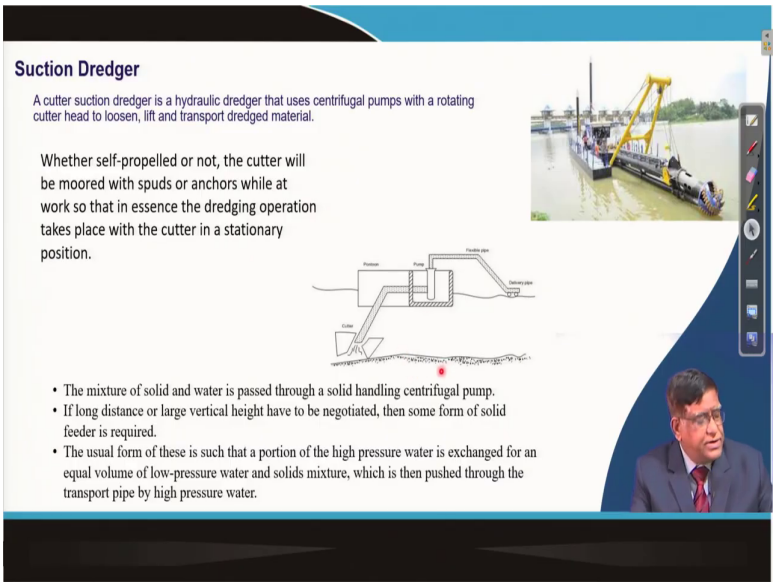

Now, this machine is a suction another thing is a suction dredger. The suction dredger, this you can see here there is a cutter and then this is a pipe through which exactly the pump will be here that pump will be pushing that material through this and then they will be processed over here and a material will be taken out of it.

Now, this as you can see schematically here we have got a cutter head and then a pump and then it is exactly a flexible pipe. So, that delivery will be taking over here. So, this whole thing is a pontoon mounted or this is a pontoon type of this is what standing on the water.

So, this suction dredger it is a; actually what is done in this? A mixture of the solid and water is passed through the your solid handling centrifugal pump that pump will be a special pump

which is also called slurry pump and then they will have to take care of that it should not that its impeller and a blade should not get worn out by the ships.

And also the environment it should not be an acidic. If sometimes some rock if they when they making slurry if the pH value of the water goes less then that pump maintenance will be a big problem. So, those things are seen over there and then this is exactly how much it will be lifted that depending on the depth of it we will have to design the system and that is very important.

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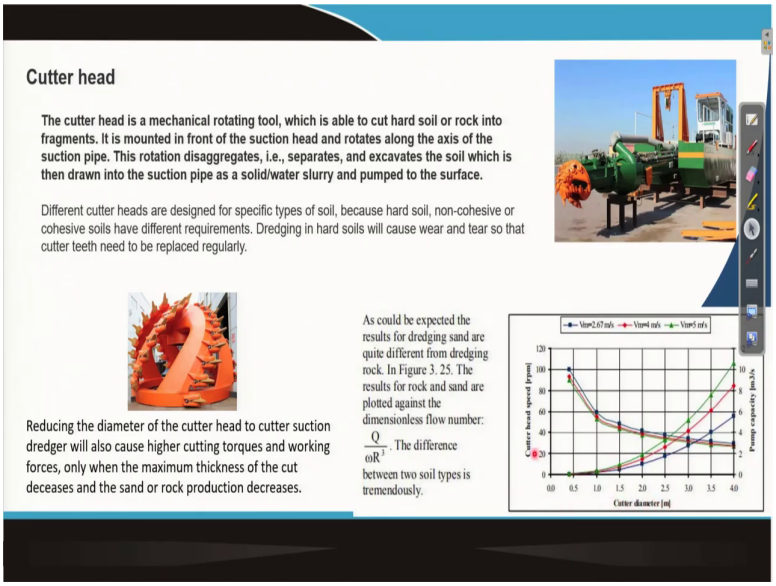

Now, you can see here that how the cutter head would look like. In the cutter head we have got also the tool holder and then there are the cutting peaks peaked over here. Now that what will be the diameter of it, what will be the number of teeth, what will be the spacing of the teeth all this things will be depending on how what type of material is being excavated.

So, you are the depending on the soil if your hard soil non cohesive or cohesive soils they have different requirements. Now, dredging in the hard soil will cause wear and tear. So, that cutter head need to be replaced regularly and mind it that under that conditions this replacement and maintenance it is the very skill job.

So, that is where exactly this there is you need to learn and study if you are thinking of working over here say for example, the Indian rare earths mineral that they have got number of dredges. Moreover, the if you have interest in this machines you can get job opportunity in the Port Trust of India.

Therefore, the dredging is also required for maintaining the ports other than that there were some this dredges it is of course, it was purchased for the dredging of the Brahmaputra river for flood management, but they could not use it, the ultimately it was send to the Kutch coastal area in the coastal area preparations.

So, this has got a tremendous use in our country for if we think of our river linking and river navigations at that time the river bed management and maintenance dredging will be very much necessary. So, I do not know if this machine is being manufactured in India or, but a some form of things can be done somebody can take up a new ventures make in India and start up to design this type of cutter heads and then do but.

In sand mining some smaller version of this machines are working, but what you need to know is that they the cutter head speed and the pump capacity that will be depending on the cutter diameter so that means, while you if you want to work on this machines how to optimize its performance this parameters need to be correlated.

So, that is a separate study if any one of you want to take any small mini projects you can start and come working on this particular aspects of it, how to exactly optimize the productions capacity by maintaining a diameter and a pump matching and exactly that is one area where lot of works are carried out lot of research takes place.

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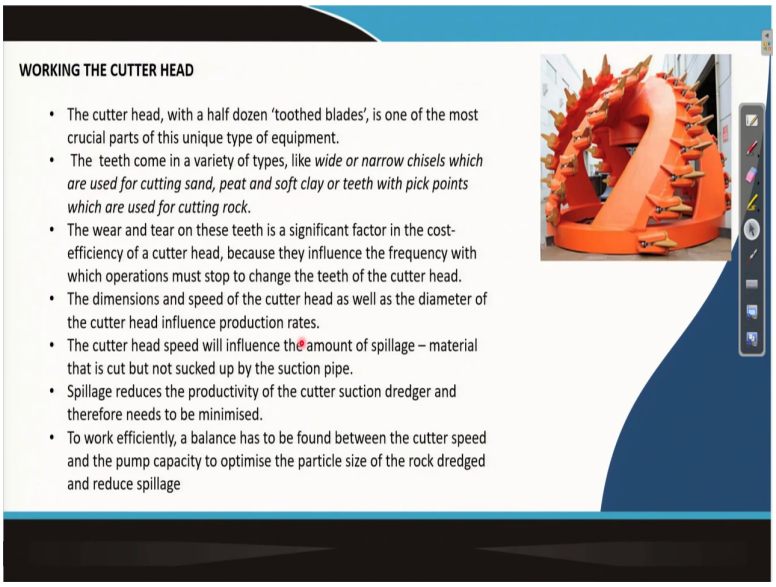

Now, they how the cutter head exactly work that is your it has got the toothed blades. You can see that blades that sometimes it is called toothed blades or peaks or cutting heads. Now, the this need to be replaced need to be maintained. Now, it is just like a chisel type of bit. So, that it can cutting sand, peat or soft clay, teeth. So, there if very hard rock comes and they get damaged then the wear and tear of this teeth is significant factor in the that cost efficiency of the cutter head.

So, if your the teeth fails very frequently your down time increases your productivity will decrease cost of operations will increase. So, that is why you will have to be very careful about its selecting. The dimension and the speed of the cutter head as well as the diameter of the cutter head influence production rates.

Now, how it does? It can be easily studied with a first you can do a mathematical model of it and then you can sometimes if anyone of are interested you can make a physical model. And then do a experimental study of how a cutter head will be performing.

A small scale design can be made in the laboratory and then similar things can be fabricated and produced. So, that type of attempts must be coming out from the young engineers like you. Now, the cutter head speed will influence the amount of spillage, what should be the space, how that will be spillage will take place, it will be going out and putting it will not go to the pumping area it will not get pumped it will be spilling it out.

So, how you will maintain that? Now, to do that control how the data will be collected from there.

Exactly nowadays everybody talk of the machine learning and artificial intelligence, here in the cutter head what type of sensors will be exactly monitoring that the spillage is taking place so, that the operator get an idea at what should be the controlling the speeds or exactly in which way the pump need to be controlled so, that the spillage material is getting collected over there.

So, there the mechatronics applications for and that collecting the data and making the machine to learn that what will be that automatically controlled. So, there if we can bring a manless that is your manless operations of the dredge that is an area where your artificial intelligence and machine learning of these machines can do it. So, I am just telling you about, but for that you will have to learn how it works.

So, this is a to work efficiently a balance has to be made between the cutter speed and the pump capacity to optimize the particle size and the rock dredge and the reduce spillage. So, what type of particle size is coming? So, what type of imaging underwater imaging underwater camera will have to be used over there?

So, taking that image online can you find out that exactly can you control the formation of the chip size because the type of the quantity of chip and their size and shape that exactly effect the pumping capacity and others. So, this is where how the study will have to be carried out.

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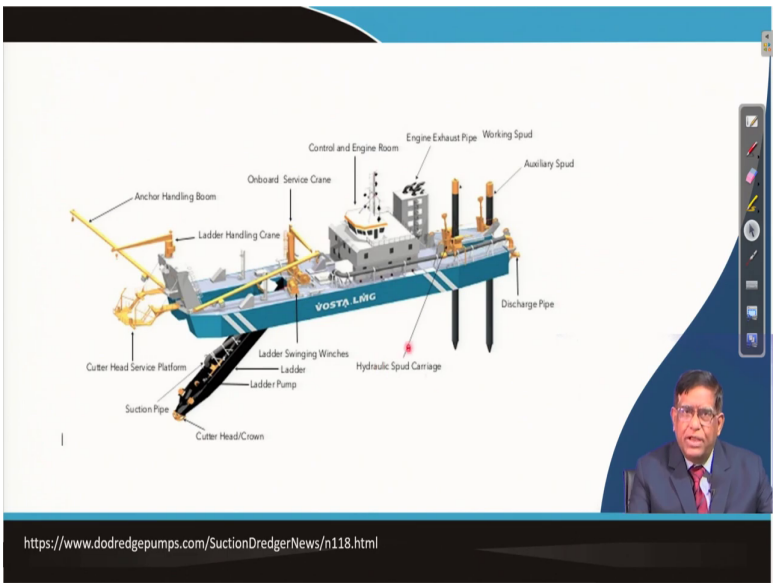

Now, you can see that is exactly if these type of machines where your it is working that cutter head services, I have shown you that this is a machines in real life you can imagine how the machine works with this figure.

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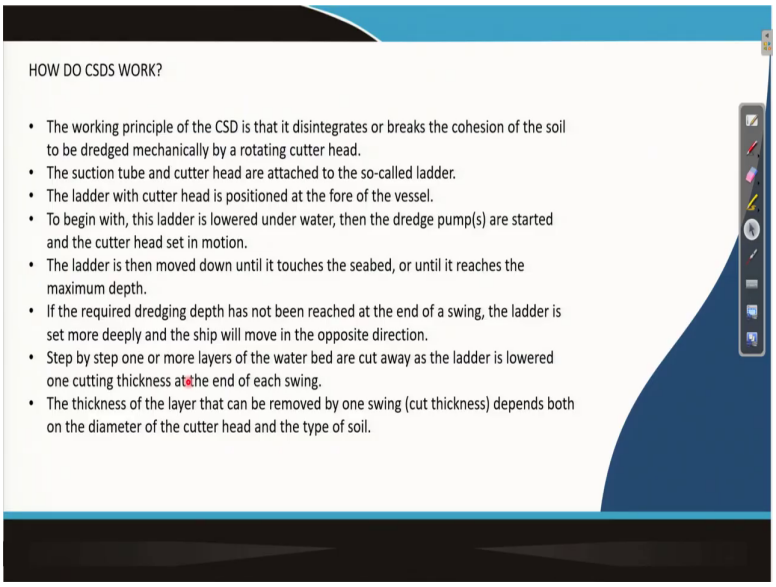

Now, this cutter suction this dredgers the cutter suction dredgers working principle is that it disintegrates or break the cohesion of the soil to be dredge mechanically by rotating cutter head.

So, there exactly the principle, in rock mechanics you have studied about the rock properties, but how the dynamics of the rock cutting and this a how this will be breaking and there what type of that is exactly there comes mainly the design of how you will be fixing the different cutters onto the cutting head.

This is a very important study. And a suction tube and the cutter head are attached to the so called ladder with the ladder you can make it. The ladder with a cutter head is positioned the

four of the special in the front you can cut it you can place it over there. Now, how the operations begins?

The ladder is lowered under the water and then the pumps are started and the cutter head set into the motion. This is that how in the sequence it will be working and then the ladder will be lowered down until it touches the sea bed or the under water bed where you want to do the cutting and then it requires the maximum depth.

So, this ladder length it could be that depending on that how your pump will be designing, sometimes if it (Refer Time: 25:33) you will have to have a booster pumping and that ladder length it is a you can make it a flexible you can make it a telescopic. So, that you can work unrelated bathymetry of the that river bed.

So, then the dredging depth is not been reached at the end of the swing the ladder is set more deeply and the ship will be move in the opposite directions that is the way how it cuts. Then step by step one or more layers of water bed are cut away with the ladder is lowered and the cutting thickness of the end of the each swing.

So, it will be swinging down in the from right to left and also it will be lowered and then it is a angle of the ladder with the ship they will be controlled and then you can get that rich for a particular measurements. So, the thickness of the layer can be removed by one swing depending on both the diameter and the cutter head. So, the machine parameters and the side conditions they need to be matched for over here.

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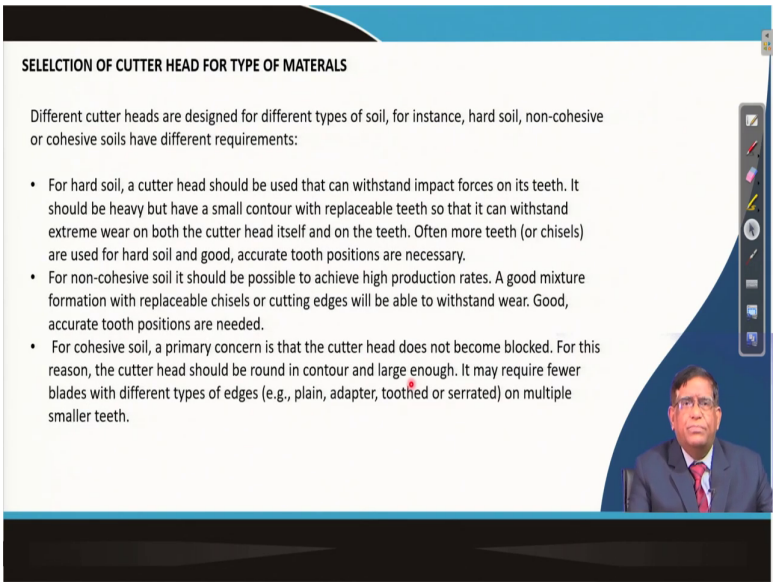

So, depending on the type of material you will have to select the cutter head. Now, different cutter heads are designed for different type of soil; for hard soil, non cohesive soil, cohesive soil they have got different requirements. For hard soil the cutter head should be used. So, that they it can withstand the impact forces on its teeth because hard rock it will be the impact will be more and then you will have to withstand that.

It should be heavy, but have a small contour with replaceable teeth. So, that it can withstand extreme wear on the both the cutter head itself and on the teeth. So, that it should be replaceable design then often more teeth are used for hard soil and good accurate tooth positioning are necessary that is a more number of closely spaced sometimes if of the short height that is exactly requirement in a hard.

But for non cohesive with that exactly it can be easily loosen there you can number of teeth may be less, the length may be more. So, your this you need to see that while you are cutting the cut material should not block that is also one of the important that is a when it will block.

If you are making it a more rotation the cuttings rate is more than the sucking rate then there will be a blocking type of situations may arise or there will be loss of material which is not cut. So, these are the things need to be considered while selecting.

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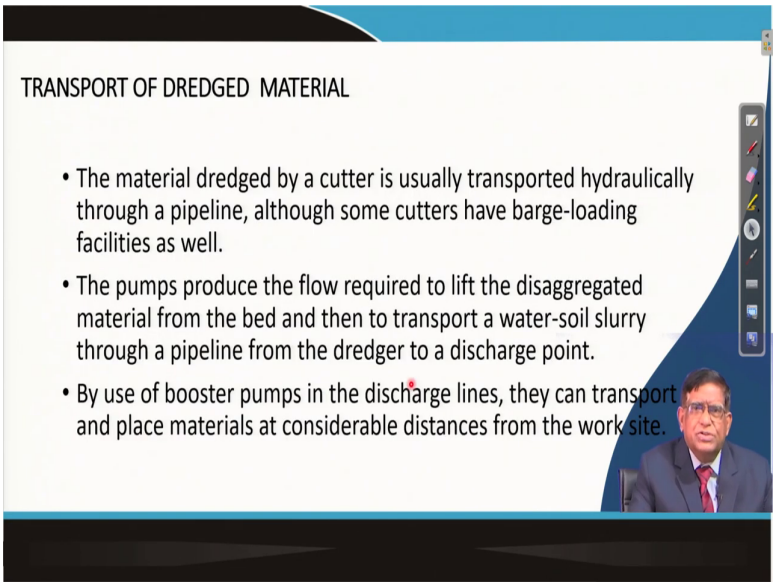

Now, you know that this how the material get transported. The material dredged by the cutter is usually transported hydraulically through the pipeline that is your it is a slurry transport its simply it is a slurry transport that is your we may in transportation machinery we may discuss little bit of the slurry transport.

And then it is also that after taking it as a slurry form it will be loading onto the barge but before that it may be doing a filtering that water parts is removed and this a residue will be loaded into a barge. So, after that the barge can carried the material wherever it is required. And then sometimes the booster pump is required.

That means, if your distance or the height or the head required is more, the same pump which is there, near their cutter head, it may not work. So, you may have to get a booster pump.

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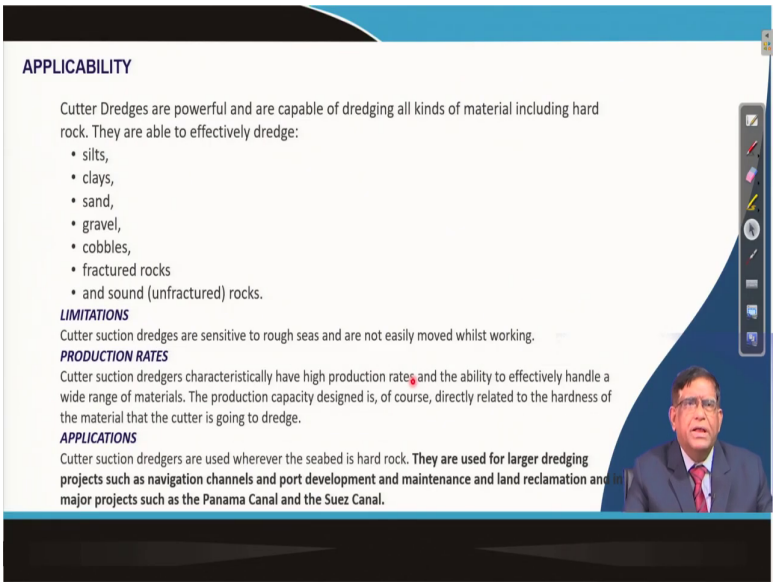

So, as it is said that if there is a sealed, clay, gravel, sand that your fractured rock all this things can be dredged and that by this method and then many times in the some of the pond clearing and all can be also done.

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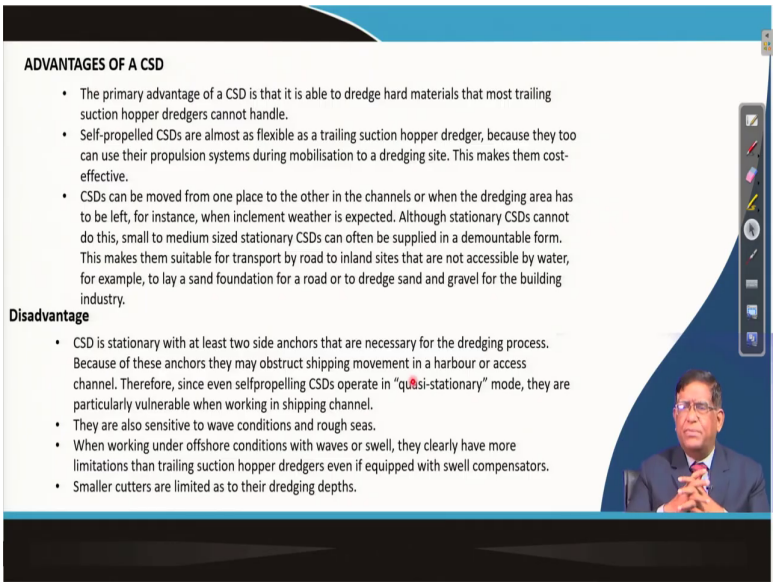

But nowadays dredger being used for sand mining very much and this machine is a it can work under different conditions and if you are judiciously using with a technological knowledge and knowhow and if you are following the designed parameters properly and referring to the manufacturer manual there should not be trouble.

But, there is a possibility of how condition based maintenance can be brought in, how reliability based maintenance can be brought into it and then the total productivity and economics of this machines can be improved by applying your knowledge input. So, this is very important that this machine has got the advantage that is your cutter suction dredges they are very advantageous in that.

It can work in hard materials and most trailing suction hopper dredges cannot handle where other cannot handle it can do it over there. And this self propelled machines they can exactly

the they have got their own drive as a ship it will be moving, but while it is working at that time it will be kept stationary.

So, this the as because it has got a self propulsive systems your cost can be advantageous over here and then it can move from one place to another. So, that is why in a whole area can be mined with the help of it. The transportation cost will not be that much just like in a surface mounted machines, because of the heavy weight transport is a more.

But you know water bound machines that transportations well cost is comparatively less and then the this machine exactly it require anchoring and that because of the anchoring there is a certain things and also with the wave and a the sea wave how it will be effecting, how it will be interacting with the other vehicular movements those things some of is a disadvantages it will be coming.

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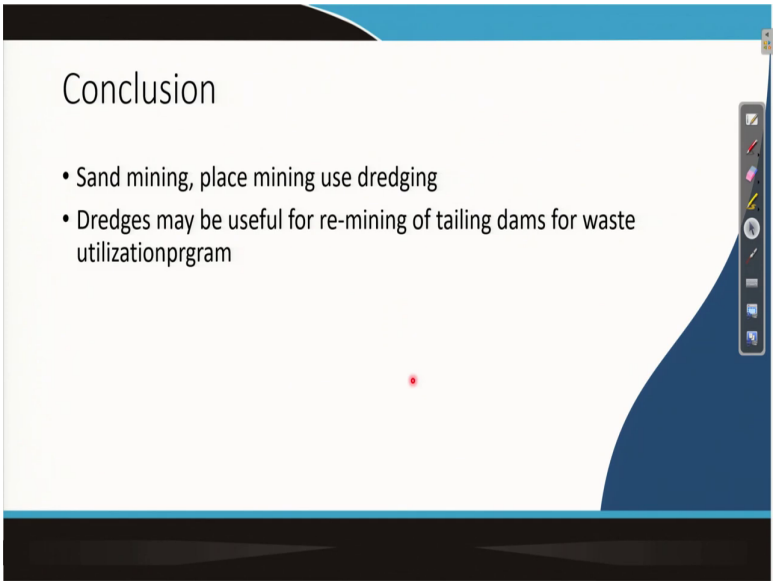

So, overall this machine has got an utility particularly in our coastal area in our sand mining area and also in a placer mining not place mining it is in case of our placer mining that placer deposits of many of the rare earths minerals can be mined by this and then dredger may be useful for re-mining of some of the tailing dams of our iron ore mines where there could be the lean ores are kept and then the tailing in which there is a good percentage of iron may be there or there a dredging operations can be useful.

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So, I hope that you study from the net there are number of articles available and also some of the this application manuals, as well as I request you to see the websites of Indian Rare Earths Minerals or the Indian Port Trust and you see that they how different dredgers are there for port management.

But as such for the mining in a underwater mining or undersea mining our country has not much developed though we have got the other methods of undersea mining which some of you can definitely study and develop your expertise in this area.

Thank you very much.