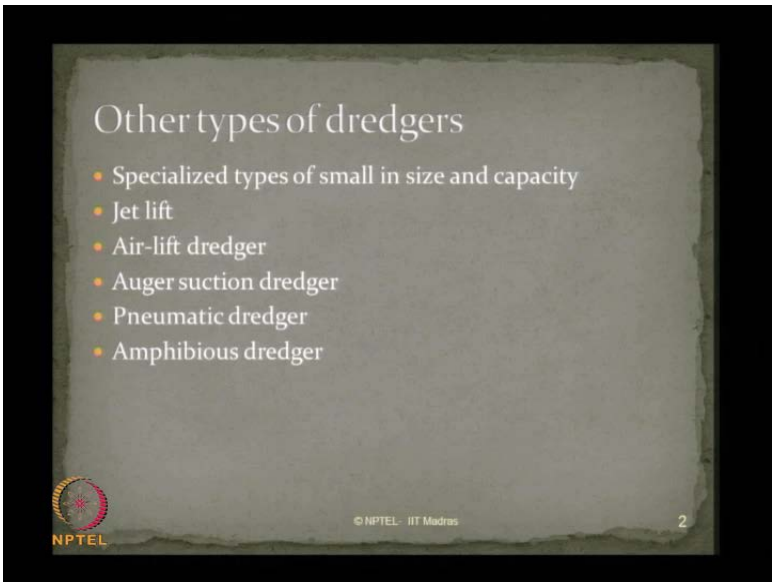
Ocean Structures and Material
Prof. Dr. Srinivasan Chandrasekaran
Department of Ocean Engineering
Indian Institute of Technology, Madras

Module - 2
Lecture - 5
Dredging II

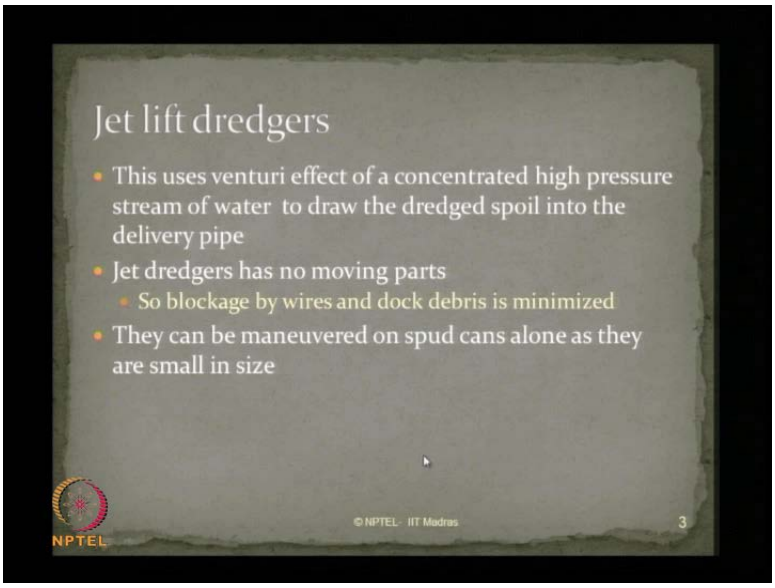
In the fifth lecture we discussed about the dredging methods and equipments, we discussed about different types of dredgers, like mechanical and hydraulic dredgers. In this lecture we will continue and take you forward for other types of dredges, which are commonly deployed in offshore operations.

(Refer Slide Time: 00:30)



Other types of dredgers are essentially under the single umbrella classification of specialized types of small size and capacity and operational rate, they are jet lifts, air-lift dredgers, auger suction dredgers, pneumatic dredgers and amphibious dredgers.

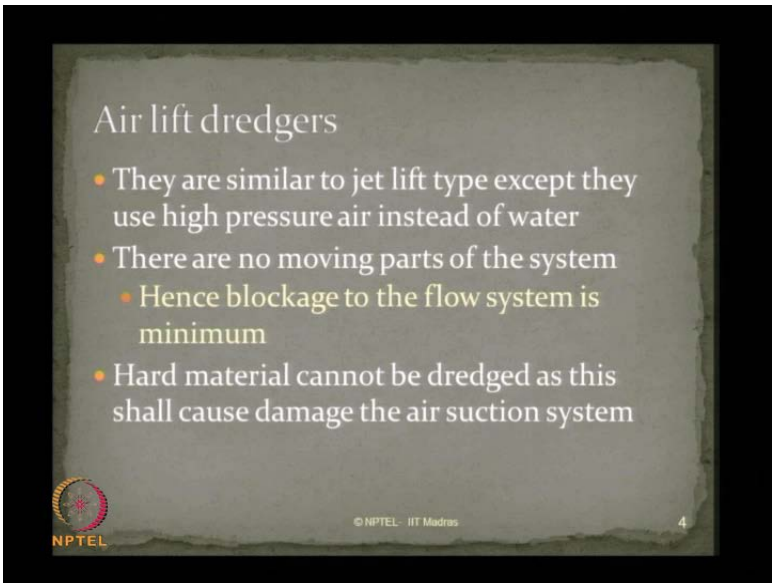
(Refer Slide Time: 00:55)



If you look at the jet lift dredgers, these dredgers use venturi effect of high concentrated pressure stream of water to draw the dredged spoil into the delivery pipe. As you understand in the last lecture, it is essential that the dredged spoil should be first loosened from its source and site, and then it should be sucked or it should be transported through a pneumatic system. In jet lift dredgers system, the high concentrated pressure stream of water is used to draw the dredged spoil from the settled spot in to the delivery pipe.

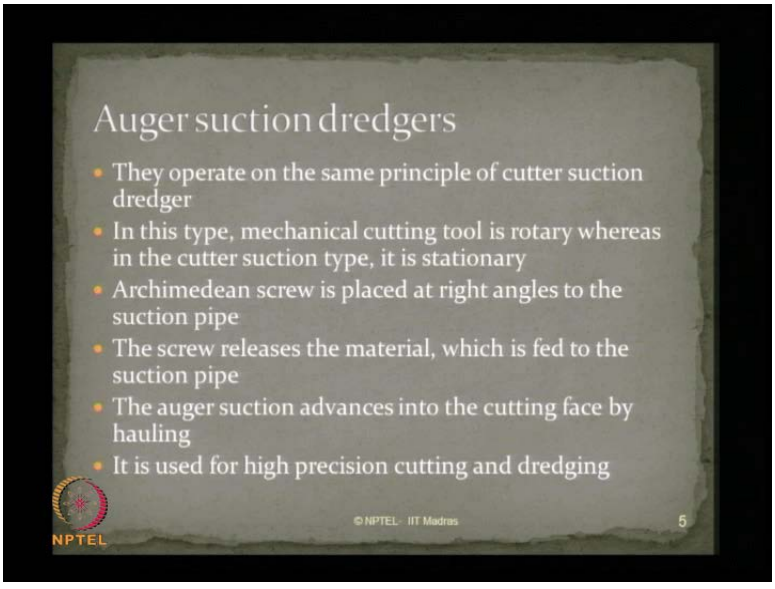
The jet dredgers, fortunately, has no moving parts. Therefore, the blockage by wires and dock debris is minimized in this kind of operation. They can be easily maneuvered on spud cans as they are very small in size.

(Refer Slide Time: 01:59)



If you look at the air lift dredgers, alternatively, they are similar to jet type dredgers except that instead of high stream pressure water, these kinds of dredgers use high pressurized air. There are no moving parts in the system, therefore no blockage to the flow system and if at all any blockage occurs, that occurs to the minimum level of, on operation. Hard material cannot be dredged using this system, because this can cause damage to the air suction system in the dredgers.

(Refer Slide Time: 02:36)

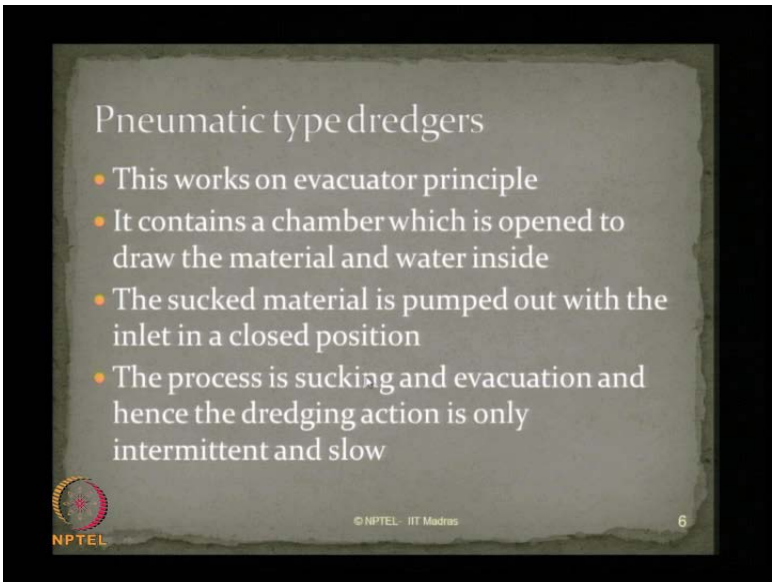


Alternatively, you have another type of dredgers, which is called auger suction dredgers.

They operate on the same principle as that of cutter suction dredgers, which you saw in the mechanical type of dredgers. In this type a mechanical cutting tool is rotary, whereas in the cutter suction type, the cutting tool remains stationary.

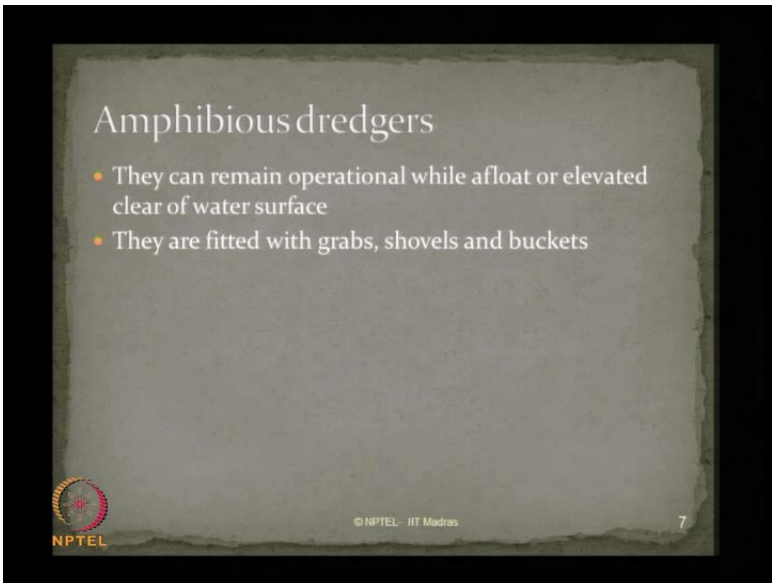
Archimedean screw is placed at right angles to the suction pipe. The screw releases the material, which is fed to the suction pipe when it is being entering the pipe. The auger suction advances into the cutting face by hauling operation. It is used for very high precision cutting and dredging.

(Refer Slide Time: 03:24)



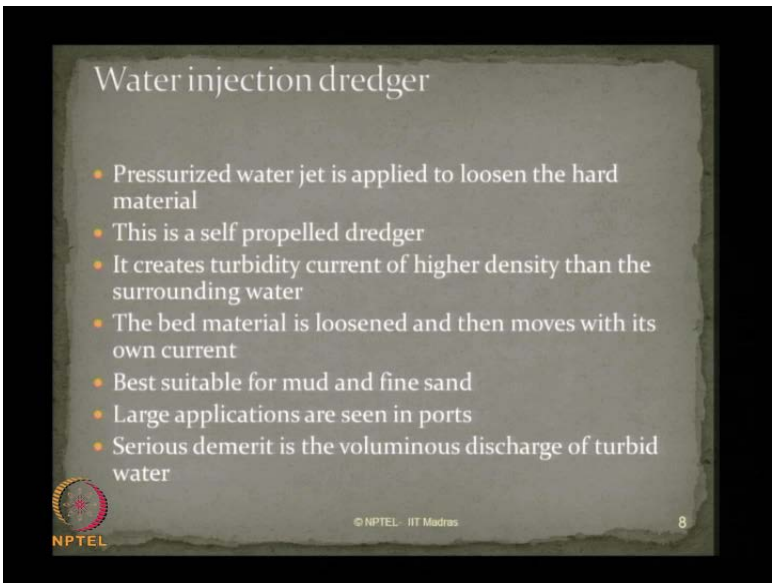
You can also have pneumatic type dredgers, which works on evacuator principle. It contains a chamber, which is opened to draw the material and water inside the chamber. The sucked material in the chamber is then pumped out with the inlet of the chamber remain in a closed position. The process is sucking and evacuation and hence, the dredging action is only intermittent, because it has got first sucked into the chamber, then the chamber is closed and then it is released. Therefore, the operation cannot be continuous as it is successive flow of sucking and evacuation.

(Refer Slide Time: 04:09)



You also have amphibious dredgers. They remain operational while afloat or elevated clear of water surface. They are fitted with grabs, shovels and buckets, which are similar to that of mechanical type of dredgers, but of course in smaller size.

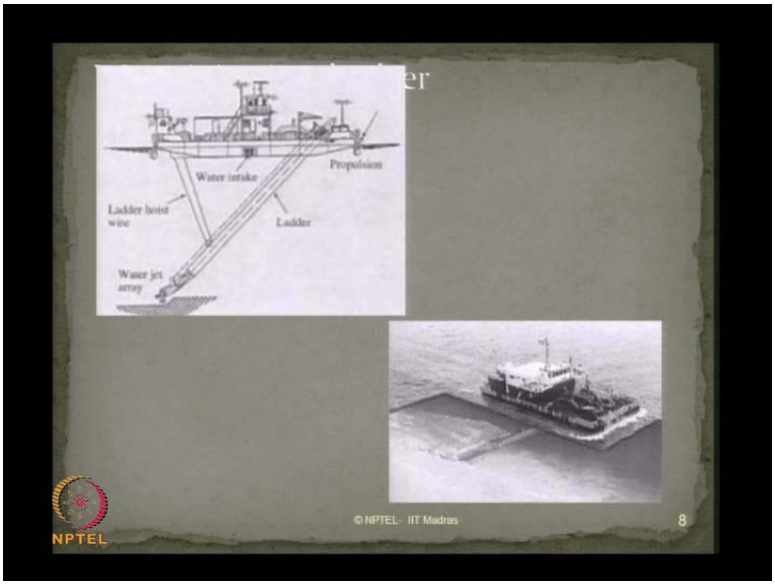
(Refer Slide Time: 04:28)



You also have water injection dredgers. The pressurized water jet is applied, essentially, to loosen the hard material, which is deposited this is a self-propelled dredger. It creates turbidity current of very high density than the surrounding water. The bed material is thus loosened and then moves with its own current into suction tube.

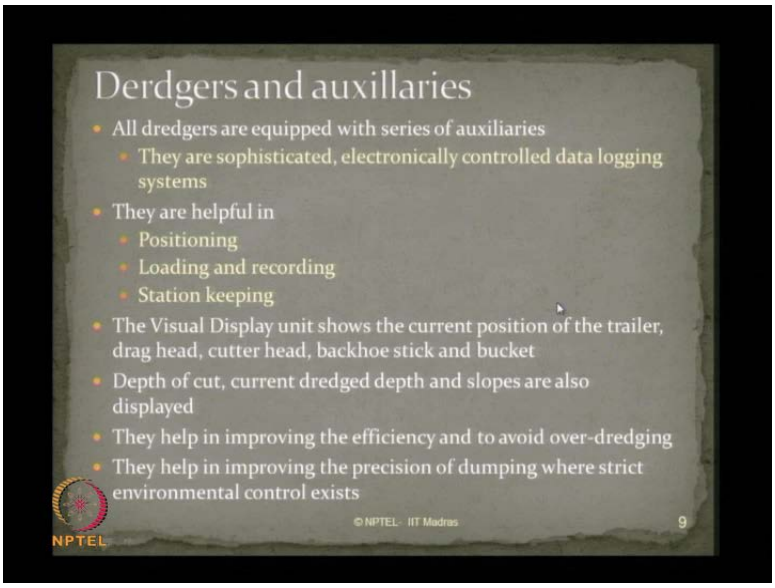
It is best suitable for mud and fine sand of dredged spoil. The larger applications of these kinds of dredgers are seen in ports and harbors. Serious demerit of these kinds of dredgers is the voluminous discharge of turbid water.

(Refer Slide Time: 05:17)



This is a pneumatic water jetter, which is having a water intake system available here, which is supplied with a self-propulsion system. It has got a long ladder, it has got series of buckets, which has got a water jet array, which keeps on pouring the water jet inside to loosen the material and then material is sucked up using grab or a bucket. Now, the ladder is supported from the dredger reversal by a long hoisting wire, which we call as ladder hoist wire. This is a similar dredger in operation. As you see, once the dredging starts and fine sand and mud is being dredged up completely, as you see, as a pictorial view.

(Refer Slide Time: 06:01)



As you see, the dredgers and auxiliaries are also important. All dredgers are equipped with series of auxiliaries. They are sophisticated, electronically controlled data logging systems. They are helpful in positioning a dredger, loading and recording and station keeping.

Dredgers, while they are in operation, generally the visual display unit shows the current position of the trailer, the drag head, the cutter head, the backhoe stick and the bucket. When they are in operation the depth of cutting, current dredged depth and the slopes are also possible, get displayed on the VDU. As the dredging operation continues, they help in improving the efficiency and to avoid over-dredging. They also help in improving the precisions of dumping where strict environmental controls do exist.

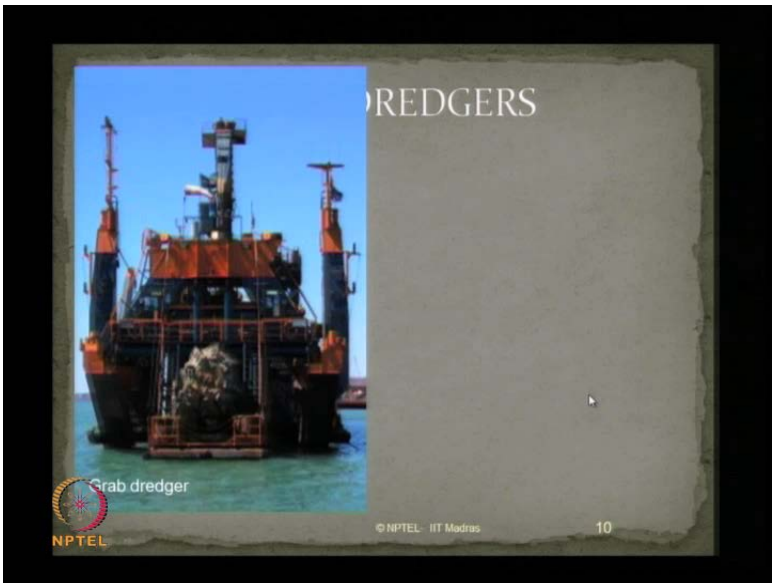
(Refer Slide Time: 06:55)

As we saw in the previous lecture, different types of mechanical dredgers, like bucket dredger, dipper dredger, common examples, as we saw in the last lecture, are clam shell dredgers.

(Refer Slide Time: 07:11)

The photograph now shows you clearly, that this is clam shell bucket, which is doing dredging in this operation and keeps on transporting the dredged spoil into a barge. As we see here, this is actually a dredger, which is supplied with the self-propelled engine, which can be placed in position with that of spud cans.

(Refer Slide Time: 07:32)



This is a grab dredger. As you saw in the previous lecture, grabs are nothing but buckets, which has got two half shells, which can open, then fix this spoil and get deposited in the containers.

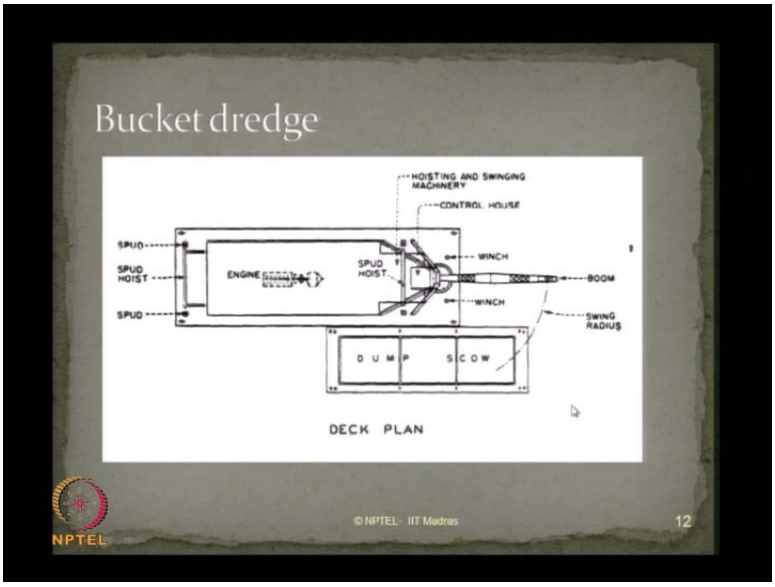
(Refer Slide Time: 07:46)

This is clam shell dredger, which you saw in a video in the last lecture how does it operate. Of course, these kinds of mechanical dredgers, though the operations has less volume of picking of dredge spoil, but the efficiency are much superior to a parallel bucket type or ladder type mechanical dredgers.

(Refer Slide Time: 08:11)

The commonly adapted clam shell dredgers, as pictures. As you see here, this is a clam shell, which has got two (( )) in this center, which has cutting edge, as well as, this opens and dredged spoil is discharged. This is a photograph, which shows, that the clam is picking up the dredged spoil and supplied to the rotary crane, which can rotate and dispose this dredged spoil from the site to that of barge located nearby.

(Refer Slide Time: 08:42)

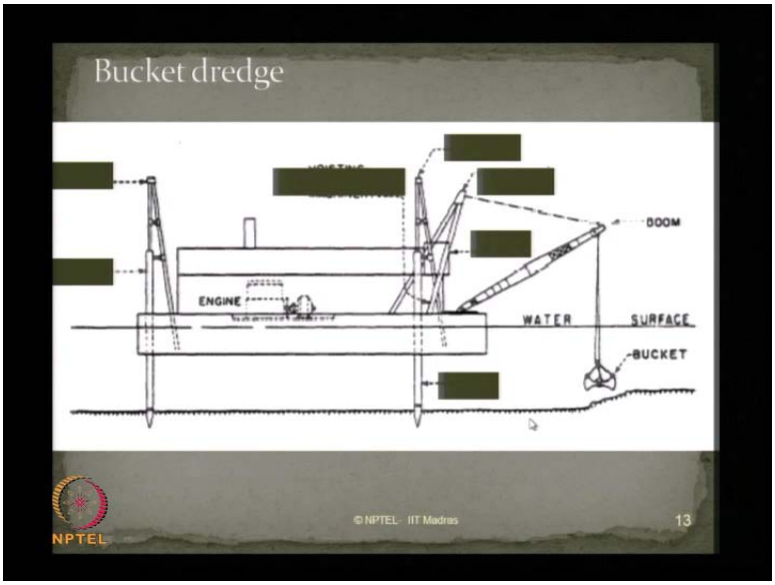


The bucket dredge is, what you see here, has different parts of important machineries, which are operating with dredgers. This is having the self-propelling engine, which can

be supported by the spud cans where this can be position restrained while it is in operation. The bucket dredger has a very long move and has got a winch based on which the whole operation of cycling or the swinging radius is controlled by the spud hoist.

As you see here, the hoisting and swinging machinery and the control house are all located in the front side of the dredger. The dredger also has a dump scow parallel to that, attached to this. Therefore, water spoil is being dredged from the side, can be rotated and can be deposited in the dump scow here and from the dump scow can be further transported to the deposit side as the requirement may be.

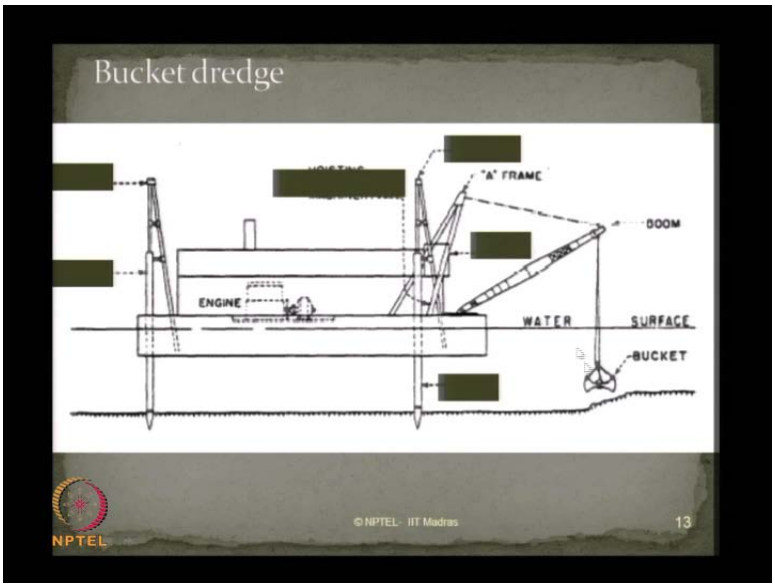
(Refer Slide Time: 09:43)



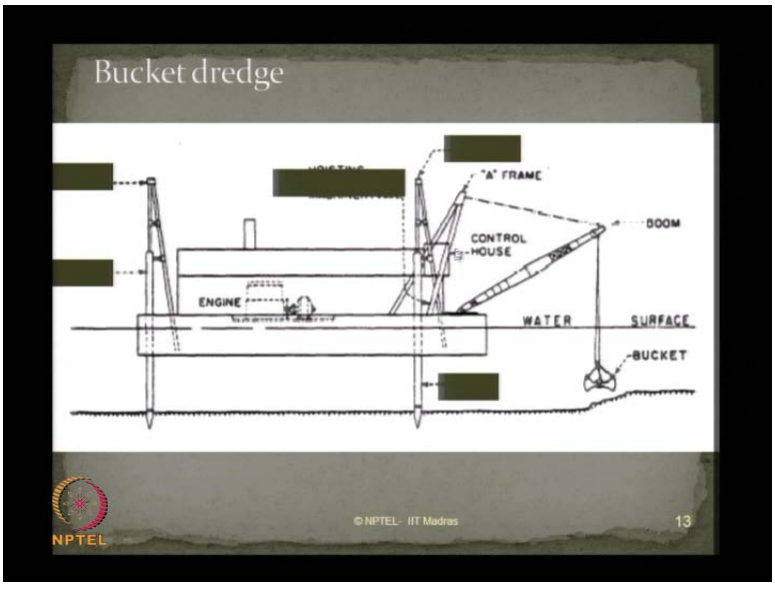
Ladies and gentleman, interestingly this figure tells you what important mechanical components, which are present in a bucket dredger. This is, what you see is a bucket, which picks up the spoil from the deposit, is getting, is having a two half shell simple bucket, is having cutting edge as well, is supported by crane hope, is suspended from crane.

So, the bucket is being lowered and pulled down, as we saw in the video in the last lecture. This is nothing but boom, which can rotate particularly 360 degrees by which enabling the bucket to correct the dredge spoil around the periphery of the dredger.

(Refer Slide Time: 10:25)

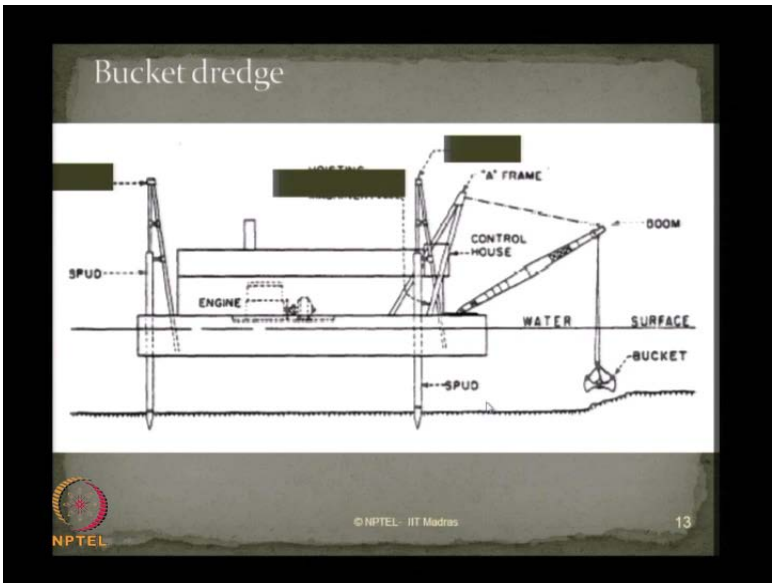


(Refer Slide Time: 10:33)

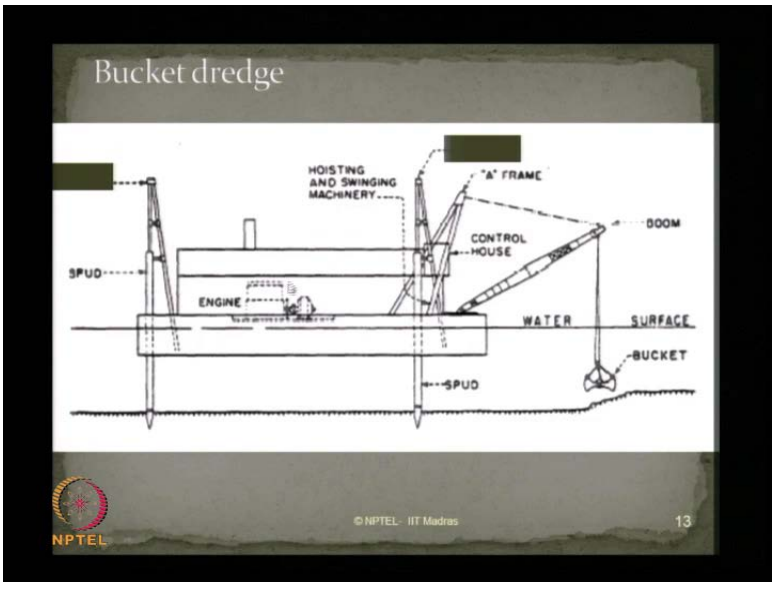


This is A frame, which supports the boom, as well as, the hoist of the bucket. This is where we call as control house, which is having the mechanism control, with, through which the whole dredger can remain in operation. These are the spuds, which are helping the dredger to keep position restrained when the dredger is in operation.

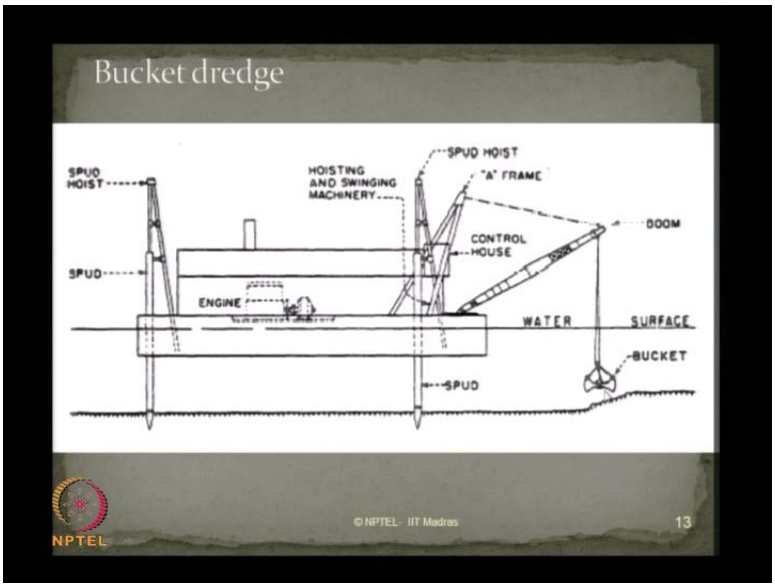
(Refer Slide Time: 10:41)



(Refer Slide Time: 10:50)



(Refer Slide Time: 10:58)



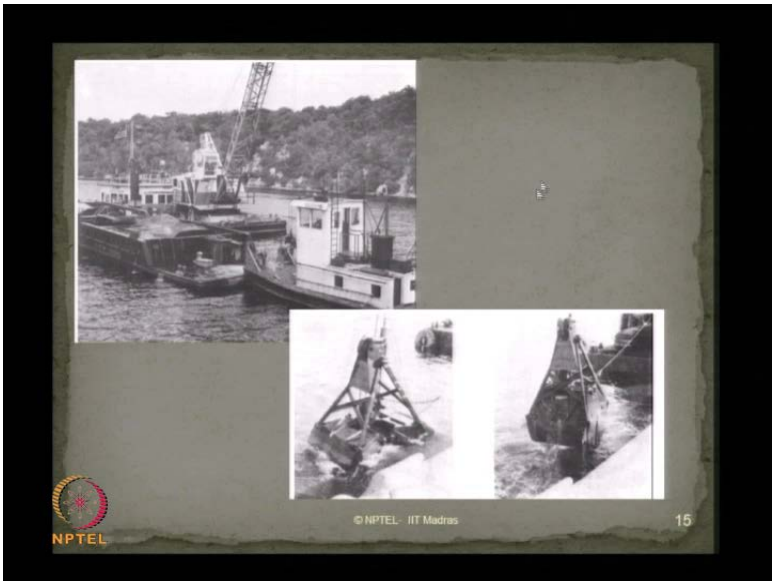
This is hoist and swinging machinery, which is actually used to operate the bucket for dredging operation. These are the spud hoist, which are controlling the movement of the spud veneration into the sea-bed when the dredger is under operation.

(Refer Slide Time: 11:10)

In case of bucket dredges, the excavated material, which we have addressed as dredging spoil, is placed in the scows, which is otherwise called as hopper barges. These are later towed to disposable areas. The bucket dredgers range in a different capacity, varying from 1 to 10 cubic meter. The effective working depth is limited to only about 30 meters.

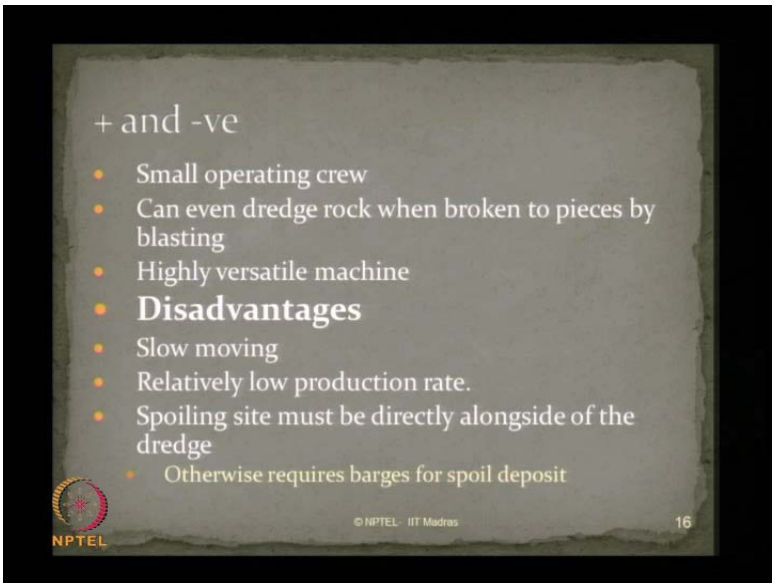
This can be used in depths to 30 meters or more, but depth is limited in terms of economical limits and drum capacity because as we saw in the last lecture, dredgers are chosen according to, very interestingly, the depth of operation and type of material, which is to be dredged from the site. The bucket dredger is not self-propelled system, but it can move itself over a limited area during the dredging process by the manipulation of spuds and anchors.

(Refer Slide Time: 12:10)



These are all photographs showing different levels of operation of a bucket dredger. As you see, the dredger is picking up the material and it is being discharged in specific form as desired.

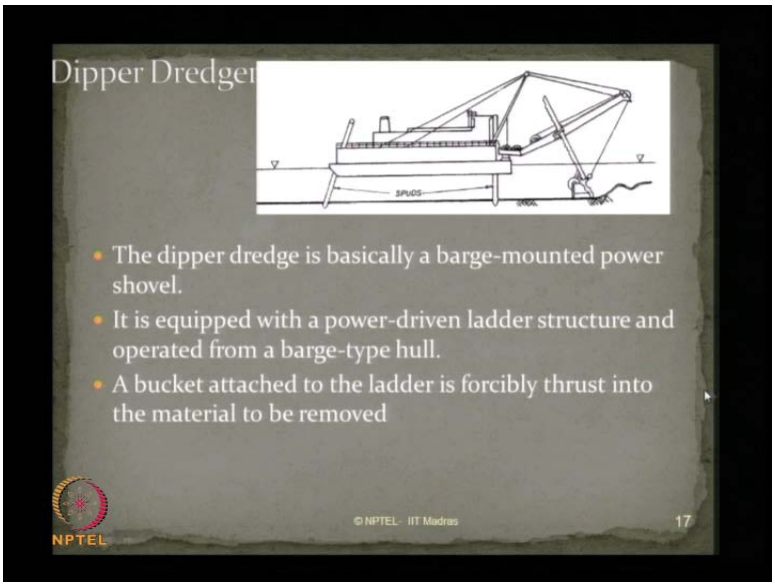
(Refer Slide Time: 12:24)



There are advantages and disadvantages of bucket dredgers. It requires only a very small operating crew. It can even dredge rocks when broken to pieces by blasting heavy versatile machine, which is very commonly used in harbors.

The disadvantages of this kind of dredgers are: they are very slow moving; they are not self-propelled; the relatively low production rate; the spoiling site must be directly along the side of the dredge. That is very important otherwise it requires barges for collecting the spoil deposit from the dredgers.

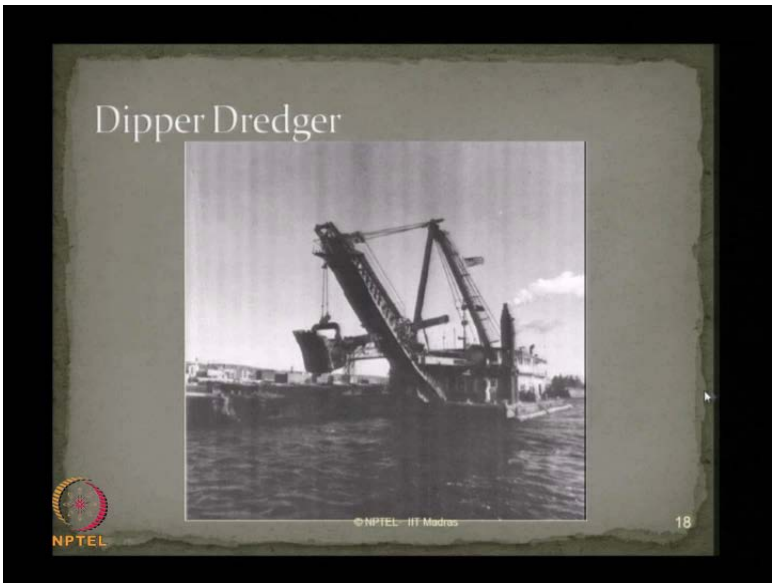
(Refer Slide Time: 13:01)



The other alternative mechanical type dredger, which we saw in the last lecture, is elaborated here. It is a dipper dredger, as you see, the dipper and shovel is provided along with this. These kinds of dredgers can also be position restrained using spuds. As you see in the figure here, the dipper dredger is basically a barge-mounted power shovel.

This is a shovel, connected to it is a frame and the A frame is connected to the hoist and that is connected in control by the vessel, which we call as dredger equipment. It is equipped with a power-driven ladder structure and operated from a barge-type hull. A bucket is attached to the ladder, which is forcibly thrust into the material and then the material is removed.

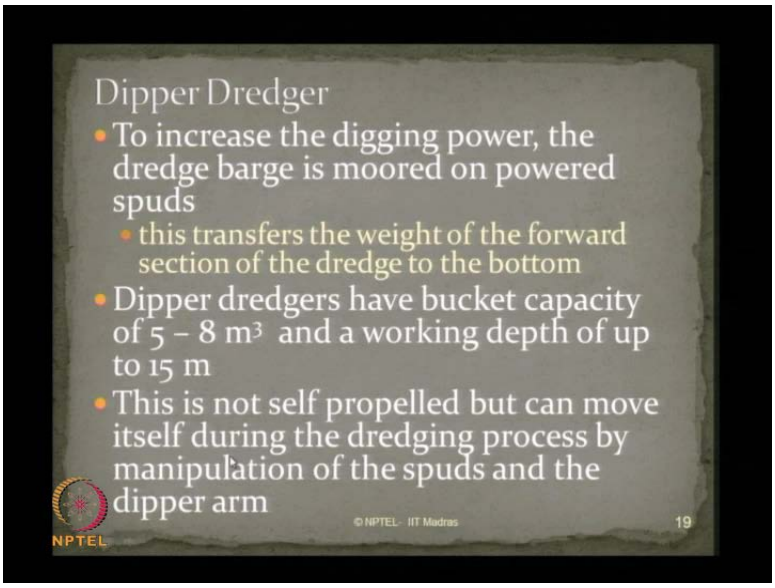
(Refer Slide Time: 13:45)



The dipper dredger operation is what you see in the photograph, here. This is a dipper; this is a frame, which you can see. The shape is A frame. The hoist, which is supporting the dipper, which has got a power shovel, which is forced into the material for dredging spoil and collected and then disposed of.

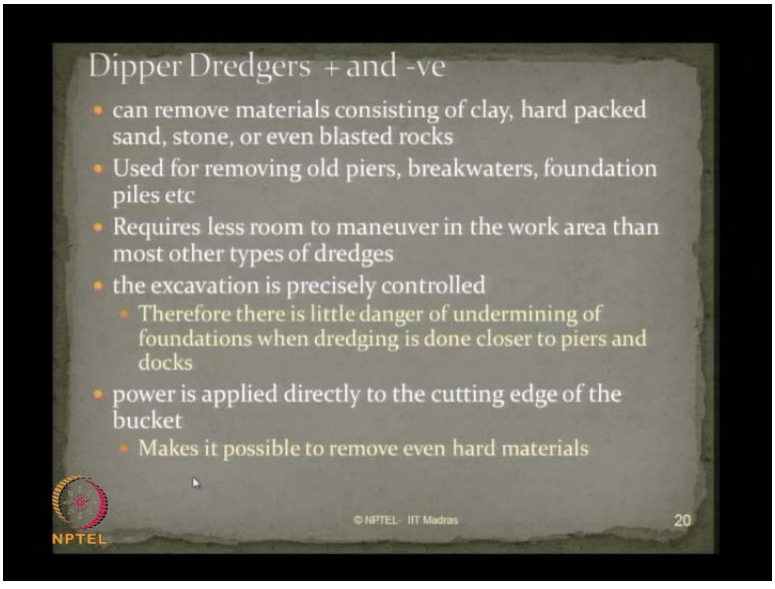
Of course, this can also rotate, but this is actually moving through the ladder arrangement and this is disposed of into the barge itself as a collection mechanism available in these kinds of dredgers.

(Refer Slide Time: 14:16)



The dipper dredgers are required to increase digging power. The dredge barge is actually moored on powered spuds if you want to actually improve the digging power. This transfers the entire weight of the forward section of the dredger to the sea bottom. The dipper dredgers have bucket capacity varying from 5 to 8 cubic meter and a working depth of up to 15 meters. This is not a self-propelled unit, but can move itself by dredging process only by a small distance by manipulating the arrangement of spuds and dipper arm.

(Refer Slide Time: 14:54)



The merits and demerits of dipper dredgers are as follows. It can remove material consisting of clay, hard packed stone, sand or even blasted rocks from the spoil site. It is used for removing old piers, breakwaters, foundation piles, etcetera. It requires less room to maneuver in the work area than most other types of dredges.

The excavation is precisely controlled. Therefore, there is little danger of undermining foundations when dredging is done. The power is applied directly to the cutting edge of the bucket, which makes it possible to remove even very hard materials of the deposits.

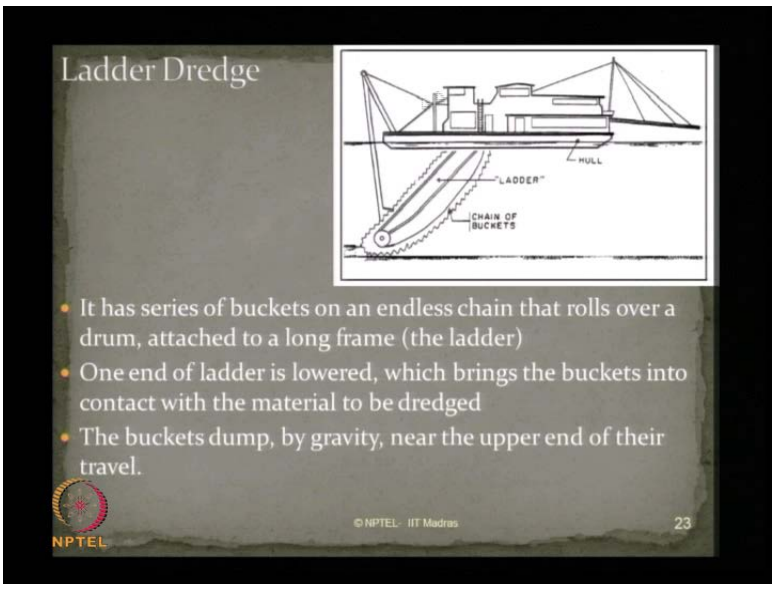
(Refer Slide Time: 15:33)

Salient advantages of this kind of dipper dredgers are, the dipper dredge type of operation limits the volume of excess water. That is very important because as the dipper fixed, the drains spoil from the side, water drains off during the operations itself. So, the volume of excess water in the barges, as they are loaded, can be minimized. The dipper dredge material can be placed in the shallow waters of eroding beaches to assist in beach nourishment parallelly.

(Refer Slide Time: 16:03)

There are some limitations of this kind of dipper dredgers. It is very difficult to retain soft, semi suspended fine grained materials in the buckets of dipper dredges. Scow-type barges are required to move the material to a disposal area. Production is relatively low when compared to the production of cutter head and dustpan dredges; not recommended for using in dredging contaminated sediments.

(Refer Slide Time: 16:28)

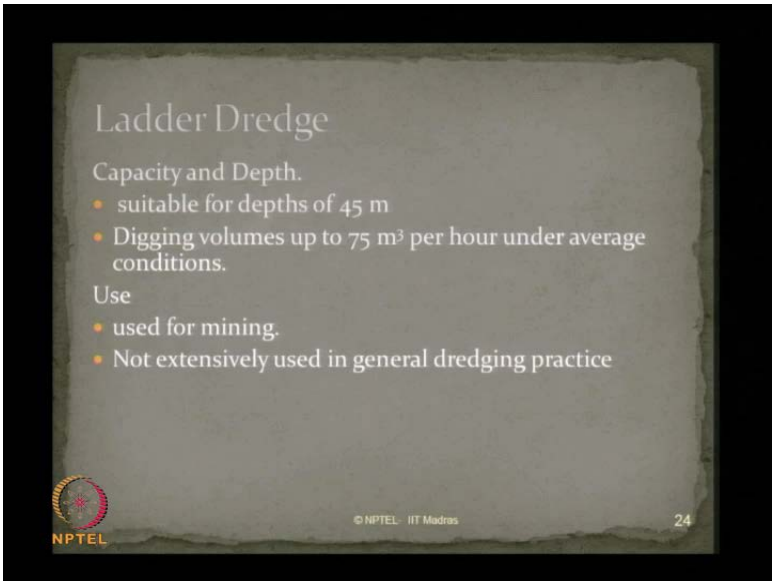


Ladder dredger is another type of dredger, which we saw in the previous lecture. I want to elaborate the parts of ladder dredger you can see here. Ladies and gentleman, this is

ladder, which is having series of buckets. The fixed rate, the bottom of the bucket is what we called as the tumbler.

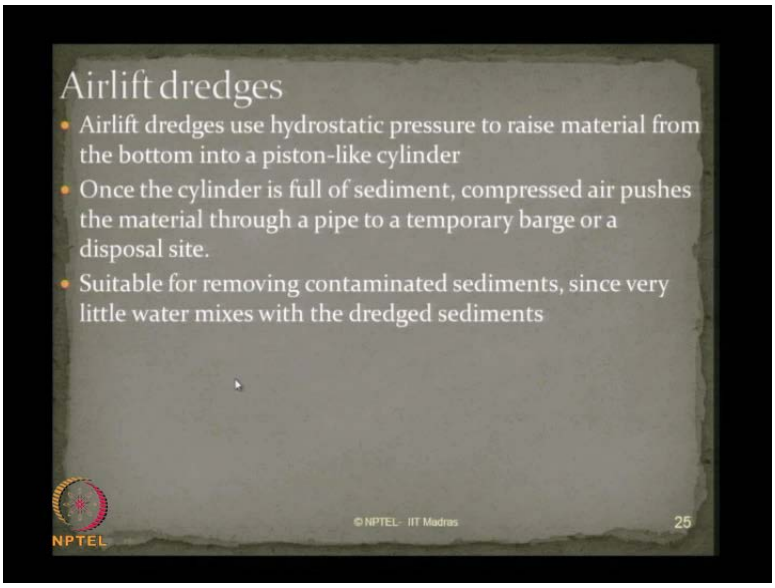
This is a ladder, as you see in the photograph, this is chain of buckets, which is cutting, collecting and transporting. And of course, this is a hull, which is controlling the whole dredging operation. It has series of buckets on an endless chain that rolls over a drum attached to long frame, which we called as ladder. One end of the ladder is lowered, which brings the buckets into contact with the material that is to be dredged. The buckets dump, by gravity, near the upper end of their travel.

(Refer Slide Time: 17:14)



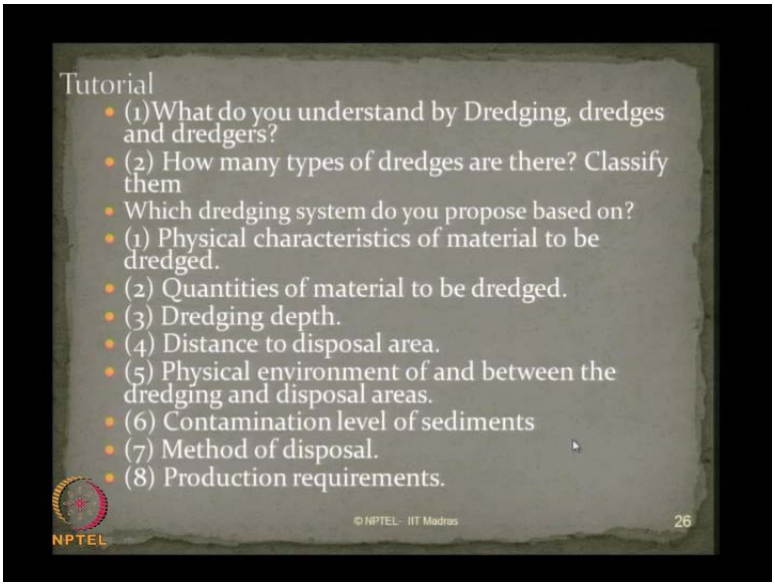
The capacity and depth depends on operational criteria of this kind of dredgers. It is seen, that this kind of dredgers are suitable up to depth of 45 meters. The digging volume varies from maximum 75 cubic meter per hour under average condition of operation. It can be used for mining, but not extensively.

(Refer Slide Time: 17:39)



Airlift dredges use hydrostatic pressure to raise material from the bottom into a piston like cylinder. Once the cylinder is full of sediment, the compressed air pushes the material through a pipe to a temporary barge or a disposal site directly. Suitable for removing contaminated sediments, since very little water gets mixed up with the dredged sediments in this kind of operation.

(Refer Slide Time: 18:03)

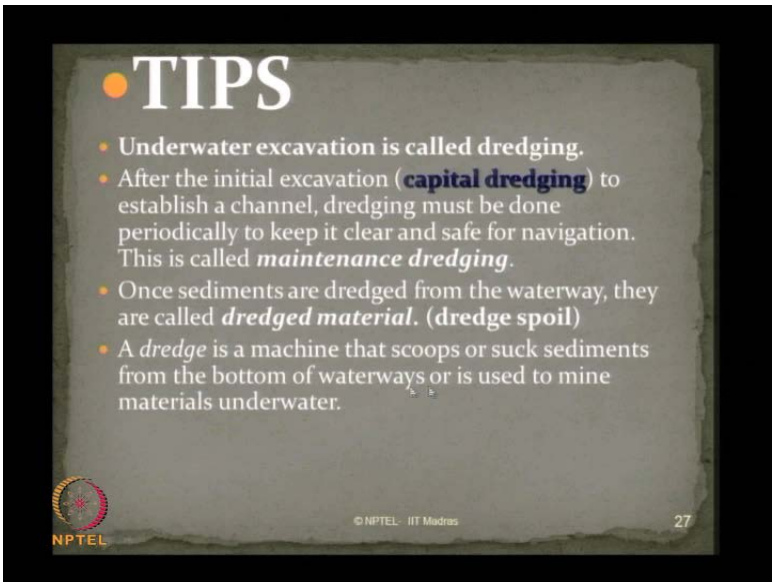


Ladies and gentleman, in this lecture of 5 and 6, we have seen different kinds of dredging operation, different types of dredgers, hydraulic, mechanical and other type of

dredgers- Their size, their limitations, their advantages and the disadvantages and suitability to specific type of operations. I have a small tutorial for you in this lecture. I want you to answer this sincerely by looking at the support material attached to this lecture, which you can see on the NPTEL website.

What do you understand by dredging, dredges and dredgers? How many types of dredges are there? Classify them, which dredging system do you propose based on the following: based on the physical characteristics of material to be dredged, based on the quantities of material to be dredged, based on the dredging depth, based on the distance from the dredging site to the disposal area based on the physical environment of and between the dredging and the disposal areas, contamination level of sediments and method of disposal. Of course, you must list them depending upon the production requirements available at site.

(Refer Slide Time: 19:19)



I can give very small tips as far as these two lectures are concerned. To remember them, underwater excavation is called dredging. After the initial excavation, what we called capital dredging. To establish a channel dredging must be done periodically to keep it clean and safe for navigation. This is what we called as maintenance dredging. Once sediments are dredged from the waterway, they are called dredged material, otherwise literature called them as dredge spoil. A dredge is a machine, that scoops or sucks sediments from the bottom of waterways or it is used to mine materials underwater.

I hope these two lectures on dredging would have given you sufficient information about the methodology and equipments of operation used in dredging process. Dredging is a very important process, which is continuously (( )) for maintaining the navigable areas in ports and harbors.

We will see in the successive lectures what are the risks involved in analysis and design an offshore structure.

Thank you.