Ship Resistance and Propulsion

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Lecture - 6

Bulbous Bow on Ship Resistance

Welcome back to the class we have been discussing about bulbous bow and its effect on resistance. We have seen the difference between ships with bulb and without bulb.

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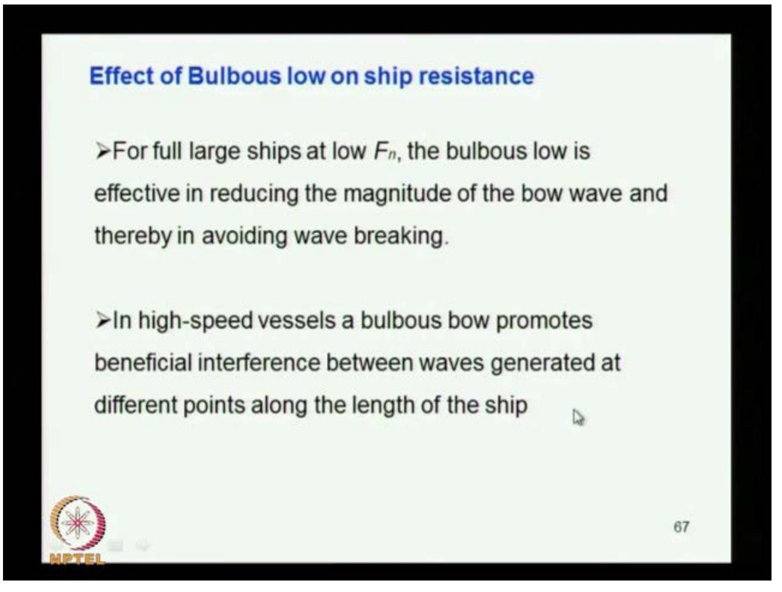

And we have seen the bulbous low got advantages in two effects. So, one is it reduces the wave breaking resistance by bringing down the size of the bow wave, and other one is primary in high speed vessels. It creates the wave system if it is properly designed and adopted bulb when it creates a wave system which will destructively interfere with the ship wave system. And thus bringing down the resultant wave of the ship and hence the wave making resistance, so the two in two counts the bulb helps in reduce the resistance.

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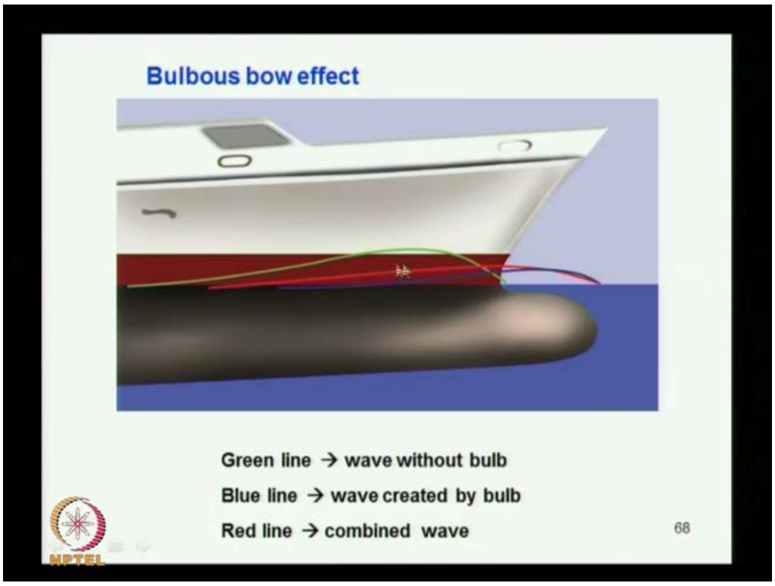

And this is the picture which I have shown in the previous class, what is the effect with and without bulb you can see that green line without bulb. Then the blue line here is the wave generated by the bulb and you can see the phase difference, which results in resultant wave shown by the red line it is a combined wave the, which effectively brings down the size of the beam. Hence, the bow wave stiffness comes from the bow wave breaking chances are reduced.

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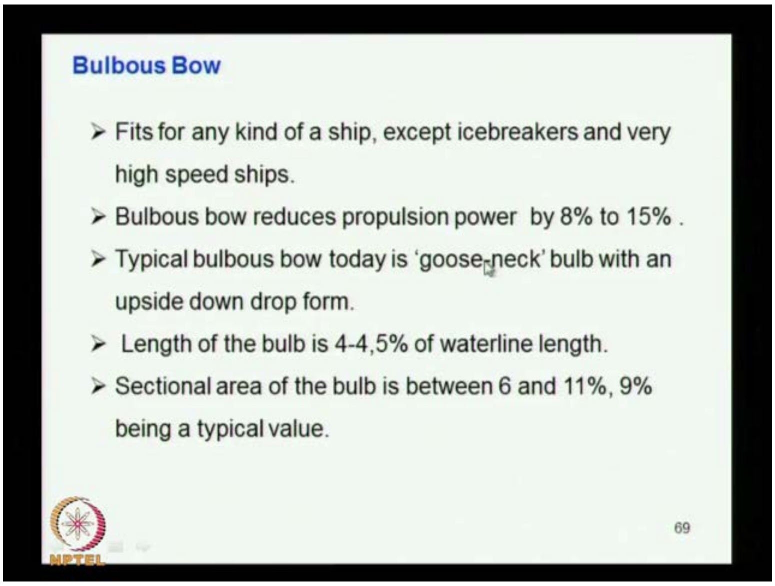

We have already seen this details we have we know that there is usually power saving of 8 to 15 percent with properly designed bulb used with a ship. And extends launching distance is usually 4 to 4.5 percent from the forward perpendicular and the bulb area is usually 6 to 11 percent. That is the cross section area of the bulb taken as forward perpendicular is about 6 to 11 percent of the mutual section area.

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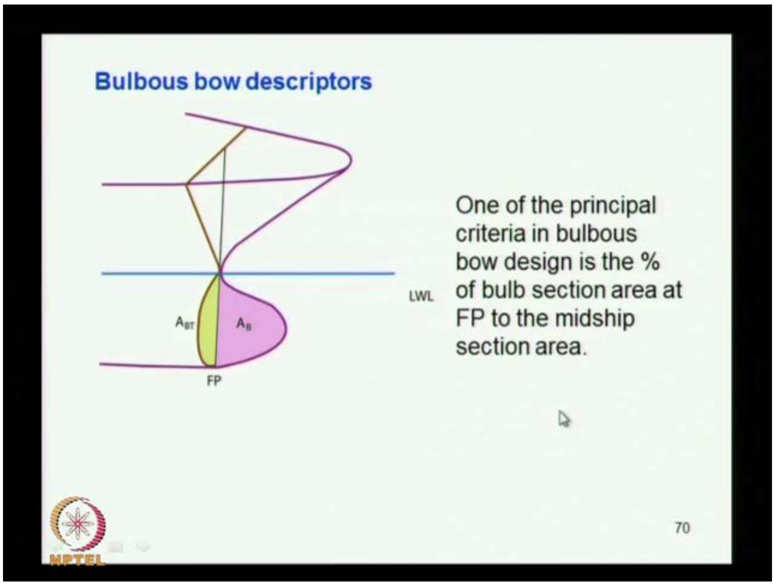

So, that is what is shown here we have the section shape that A g t is that is of the bulb area at the forward perpendicular. And that is what the percentage to set its about 6 to 11 percent normally it is 9 percent.

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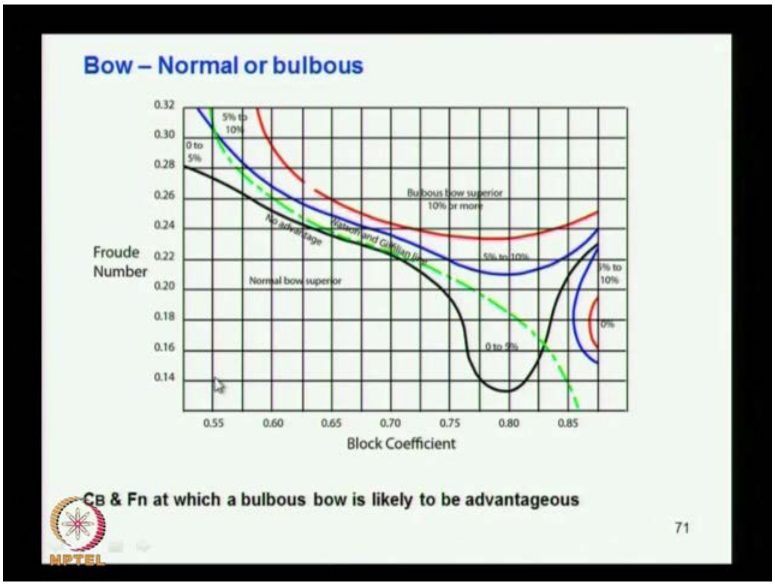

So, this diagram gives an indication how to identify whether the bulb need to be provided, whether the bulb will have an advantage. And the probation of the bulb by enlarge the defense of the fullness of the vessel and the also the Froude number of its operation as we discussed in the previous class we know that the bulb is only going to be effective only for a small speed range.

So, if the bulb is designed for a particular that is a service speed, it will become effective only a range or a small range around the service speed, beyond which it is not going to be effective, not so effective. And maybe in some range it may become 11 negative effect, because the wave making component the wave generated by the bulb may go for a consequent difference with the ship generated wave.

So, that is why the size of the bulb type of the bulb everything depends on the speed of the vessel, and also the type of the vessel which is determined by the block coefficient. Here you see that the black line here, which gives an indication what is the below that you can see that normal bow is superior, can you see that. So, we have the vessel fall in this range of course, is a vessel is 0.7 coefficient and you say it is Froude number is 0.2 which coming here so you do not have to go for the bulb, it is just normal slide stem is enough for a vessel which is a more advantages than giving a bulb.

So, whereas, you have different lines here which there green line, which shows here is a Watchson Gifillan line based on which they have analyzed that, they are given that below this line which is above that line is better to have. So, here the variation what is the advantage of the bulb we have already seen that can have a usually up to 15 percentage advantage that is based on the studies, which has been performed not to providing bulb to the ship that is the considering the case that with and without bulb for some types of ships.

It has been observed that the resistance can go or resistance can reduce by about 15 percent as a power saving of about 15 percent. So, here these lines show what is the 0 to 5 percent bandwidth then 5 to 10 percent bandwidth and above 10 percent bandwidth. So, these colored lines so you can see that if the bulb is properly designed for the ships following in this range, advantage is more than 10 percent. So, if you consider maybe a 0.75 block coefficient vessel or I can say I come to this 0.65 maybe around that is the block coefficient normally for container ships. And the Froude number is about 0.3 for container ships we can say slightly faster vessel.

So, this is the point so obviously it shows that there is a considerable advantage in proving a bulb saving can be 10 percent or more, so that is what tells so this gives a guideline based on studies whether to adopt a bulb for the vessel or not. So, that is the first step once you have arrived at it is good to have a bulb, then you have to decide what type of bulb, what is the size of the bulb as we said what should be the protrusion, length required for the bulb, what should be the area at the forward perpendicular in relation to the mid ship section.

So, these are the other parameters which go as per the decent but thing is we are not going to details of about the design and all that because that for the another course ship design. So, our course does not interfere in this range, the design of the bulb, but still we see what are the types of bulbs normally used?

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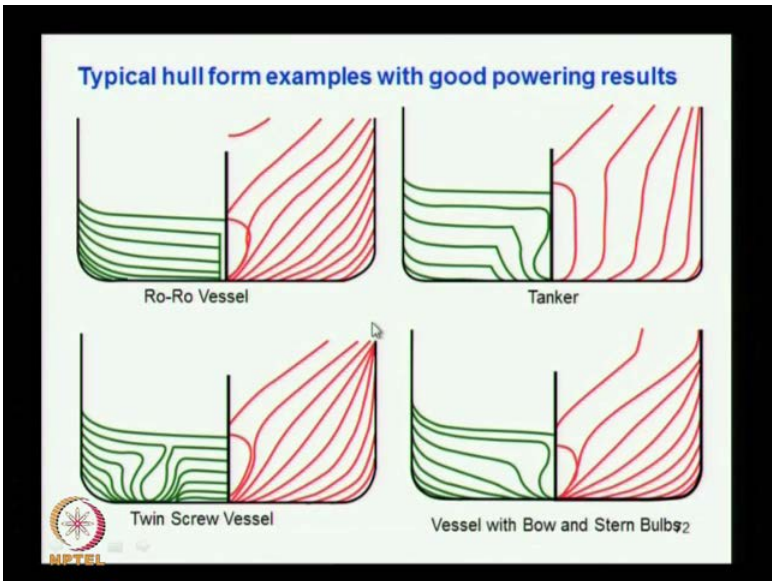

So, this is a body plan this is how the body plan are shown here for some typical vessels with bulb. So, you can see there is a bulb some sort of a this is a inverted drop shape, and you see that the form changes here, if it is a without a bulb usually this is a line straight this comes straight down and but this here what here you can see the form getting adjust adjusted to forward region, to accommodate the bulb. So, here which you see on the left this side is back section and this is a forward section of the vessels half section are shown due to symmetric of the vessel about the centerline of the ship.

So, here is the another vessel this is the another type of bulb, you can see this is the another type. So, the shapes get adjusted to that see this difference from here, so shape to the forward region get modified take on the bulb. So, bulb are formed part of integral form of the ship, here you can see there is a turn in bulb also this is some vessels they use the turn bulb, this improves the flow to the propeller as the similar the bulb in this turn region which enhances the flow condition, to the propeller. And thus the propeller become more efficient, so that is the turn bulb.

So, these cases are what you have seen here this is for the single screw, when it comes to the twin screw, twin screw again there are two types one is just ((Refer Time: 08:37)) and to get a normally big shapes, there you have the twin screw condor also formed in part of the body to get the better flow condition. You can see that this is the shape of the body that if shape takes at the form to accommodate the shaft, or through that.

So, you can see that the form gets modified drastically over this region. And obviously the construction difficult is much, much higher for this type of the vessel. And this is a another type vessel with bow and stern bulb you can see that is the both bulb both side and these are the just to show that, show the how the body form changes due to the probation of the bulb.

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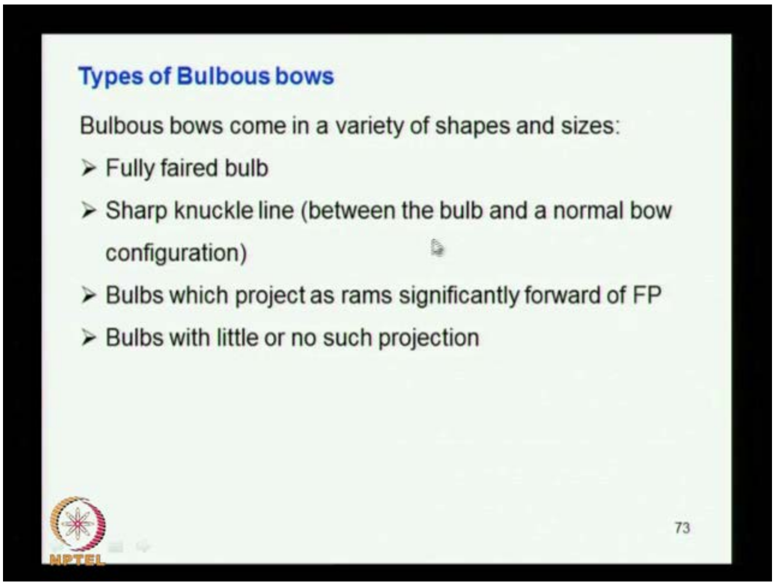

Bulbous bow comes in variety of shapes you see some in below in the next slide, some are fully faired bulb that is just formed verified with the bulb, some sharp knuckled line that is I have shown the figure before, how the knuckle shapes are looks like. Here you can see this is a I think that is missing here the way of the knuckle shapes are straight sections straight you know condors easy for fabrication. So, the knuckles come with a bulb, bulb is having a curvature whereas, a body is having straight panels.

So, then it is not going to be a faired one or its not merging naturally with the bulb, so there it will be slightly different from compare to the first one it is a faired bulb faired bulb. Bulbs which projects as a ramps some bulbs just protrude out, we call it is a ramp significantly forward. So, we call the ramp of the bulb, bulbs with little or no such projection. So, there are different categories projection maybe less some projections are very high. So, I think we have already seen a vessel here you can see the bulb see its projecting isn’t it, it is a big bulb which is provided here.

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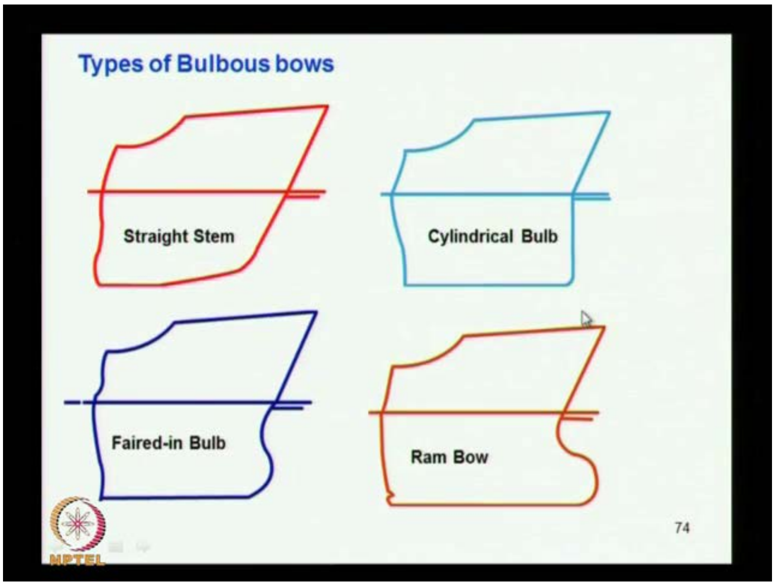

So, the size and type of bulb as I said before again determines or depends on the vessel form or vessel fullness that is C b value and also the state of the vessel, where it is a Froude number. So, these are the parameters what you have seen here you can see some typical shapes this is the case of the stem of a ship without any bulb, which is called the straight stem. This is a cylindrical bulb you can see its vertical down and here you have the bulb shape you take a section of a this bulb, you will see that you will see that you take a cylindrical bar.

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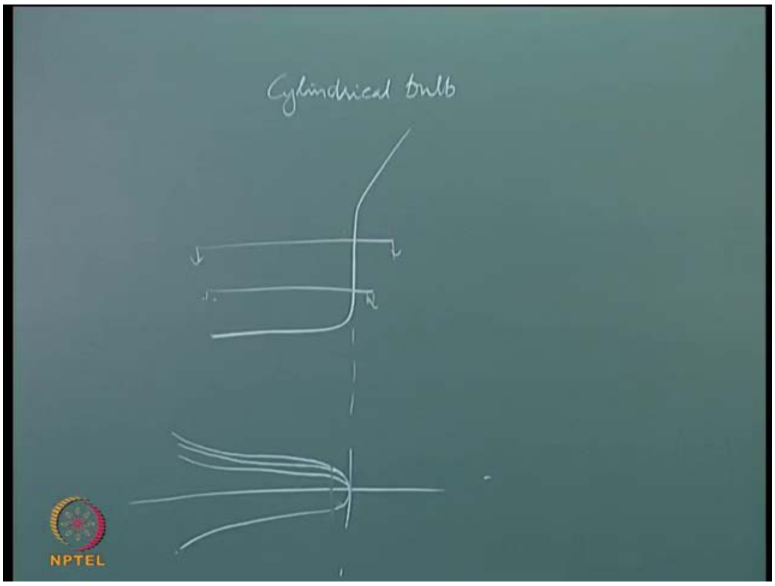

You have seen that it is just comes like this and then vertically down and then it goes like this, this is a shape. So, if you draw the half breadth plan of this, you will see that it is going to be maybe something like that, it comes it will have a semicircular shape here. So, if you draw the full section it will be a semi circle and then it goes like this, so you take a outline here. So, here also you may get the same maybe another outline which just comes here goes like this.

So, this is the shape that is the round shape the cylindrical here it is a half the cylinder, so it is called as cylindrical bulb. So, that is the shape given for that cylindrical bulb, so then you have a another faired in bulb with the small projection here. That is the faired in bulb and this is a ram bulb you know the propulsion is more you call this as a ram bulb.

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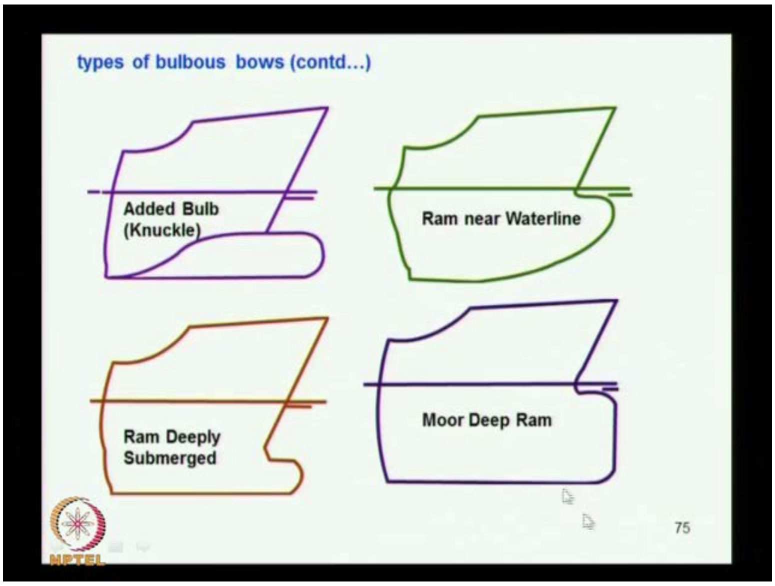

Here is the case where the knuckle shape this is a bulb with a knuckle that is straight are plates are used. And this is merged with a bulb here which also has got a protrusion, then you projection taken closer to the water line the previous case, or even here you can see the projection is at the bottom. Whereas, here the projection is or the ram is close to the free surface, so that is determined by again the type of vessel or fullness and also the float number, this is the another with a deep ram that is it is not only small portion it is once over a lot of depth portion. So, these are the different types you may encounter in literature more other shapes of bulb, so this is a the inverter drop type.

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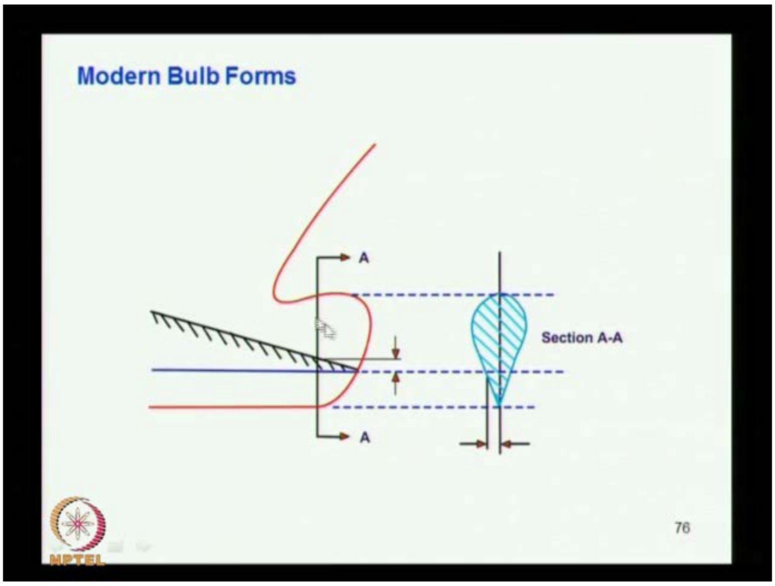

You can see that is a bulb shape like, this if you take a section this is the section you have and concentration of area towards it, here the advantage is when the ship moves up and down if this will this shape will give a smooth re-entry of the bulb to the water. So, if it is the other way you just take the drop shape, then when the vessel move up and down then exposed bottom vary will be more and naturally it will get an impact. So, that is bad for the vessel, if the vessel is subject to frequent slamming. So, which is not acceptable.

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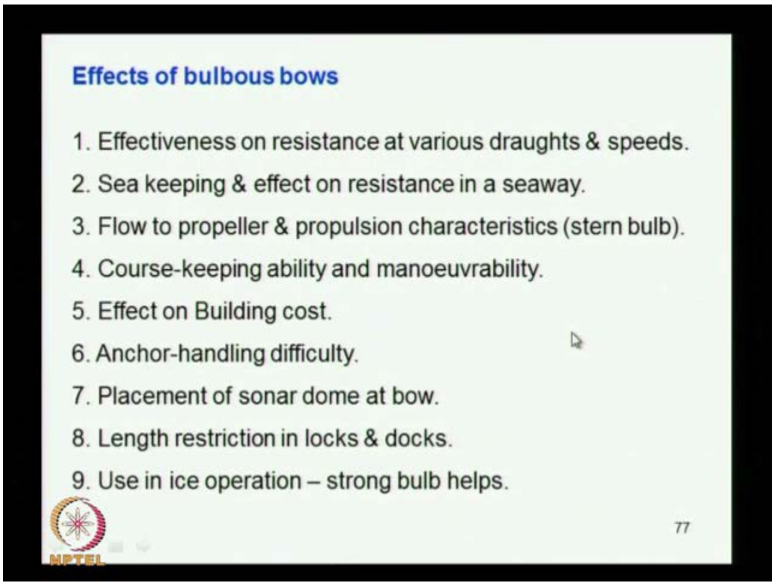

So, what are the effects of bulbous bows, so bulbous bow as we have already seen that effectiveness on resistance on the various draughts and speed. How do you determine the vessel you are fitting vessel with a bulb which is suppose to be the best option at the particular draft, usually decent at maximum load and draft and for a particular ship that is for a particular C b, and particular speed usually at the service speed.

So, these are the options you consider when you select a bulb or design a bulb for a particular ship, but the same bulb when the ship operate at a different loading condition may be at the light load condition, then the bulb performance is going to be different is not same as, as it performs for a fully displaced condition. So, draft matters there speed also as I said before it is a best performance in the service speed for which it has been designed.

And it operates at the different speed the performance level also goes down, so the effect positive effect which you expect from that bulb may not be available at different operating condition, these are for different draft and different speed for the same vessel. So, that matters a lot there is a problem with the ship bulb, you consider a tanker vessel with a bulb. So, that is effective when tanker is operating in fully loaded at the condition speed, when the tanker is making a return voyage you just consider India is importing oil, crude oil from Gulf countries like Iraq may be Iran and all of that.

So, when it comes to the Indian court it is the fully loaded condition, when it makes a return trip it is a holes are empty, so it go by ballast that is some compartments exclusive meant for filling sea water at these compartments are filled with a water sea water pumping water which you call ballasting of a ship. So, which gives sufficient emulsion for the ship, why is sufficient emulsion is required? The propeller should be sufficiently submerged then only it will generate, generate trust and propel the ship forward.

So, naturally you have to have minimum draft for the ship if you if you do not ballast the propeller will come out of water is a chance. And also ballast condition you know that there is a trim provided you should trims by half you show the propeller is sighted in the draft of the ship it ((Refer Time: 17:51)) so to get sufficient submergences for the propeller, propeller will become more effective. You know that when it propeller is close to the surface, there are variation gravitation problem and all that this should be minimized. But in ballast condition you cannot help it, it may be irrational problem there is the propeller close to the surface or even maybe you do not get hundred percent emulsion for the propeller.

The propeller maybe immersed only for maybe 80 percent, so at least 80 percent of the emulsion is required for the propulsion. Suppose, you fill get try to get maximum displacement even in the no load condition, you want to have the same draft as in the fully loaded condition. It may not be possible because you do not have a space to fill water one thing, second thing even if it is possible you have a space the displacement will become high, weather surface become high unnecessarily you are spending to much energy to propel the vessel.

So, you want to have minimum wetter surface low wetter surface, so low resistance because you know that is proportion to the wetter surface resistance is proportional to the wetter surface. So, you consider various options now you consider ship with bulb, which is operating in a light load line condition. So if you consider that if you just consider a ship.

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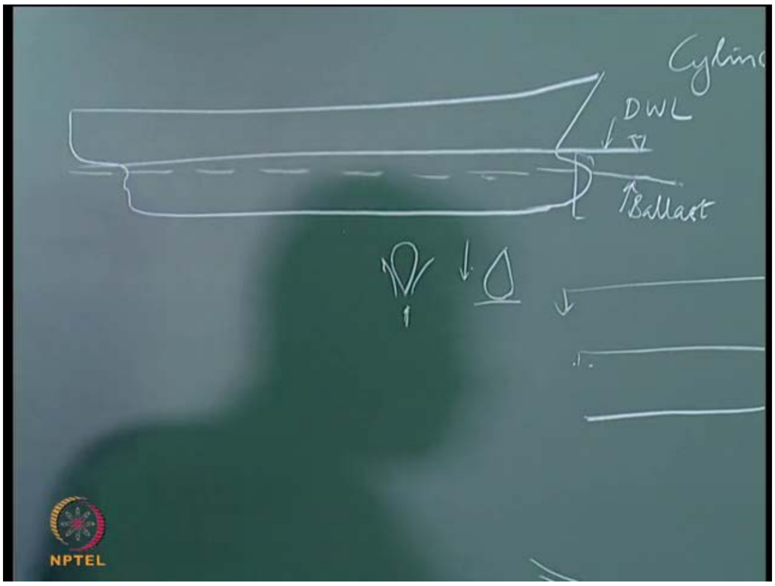

With bulb which is which flows at this water line in the fully loaded condition. That is when it is moving with cargo, when its fully loaded that is a design load water line and that this design water load line, there is a portion of the bulb. Now, you consider in the light load condition water line water level comes down. So, that and trims by this portion so the water line will be something like this. So, this is the case this is in designed load water line, and this is the case in the ballast condition.

So, you give trim by half the total displacement is less as I said it may be around 40 percent. So, the water level is here that is part of the bulb is outside the water level. Now, there is a high chance of the bow part of the ship or the bulb coming out of water in the same condition and re-enters the water with a gravity action and leads to slamming effect. So, this is another problem if you do not give the proper bulb it emerges out mainly in lightly loaded conditions re-enters with the tremendous velocity, leading to impact load which you call the slamming effect. And this may damage the bulb and the ship size.

So, if the bottom is made flat as I said before if it is a drop shape, in place of the inverter shape if you get a shape for take the section, if the shape is going to be like this, when it reenters this is the region which is subject to so the more area is now exposed to the surface. So, the impact load will be high isn't it if it is a other way which is a inverter drop shape when the water enters this direction it give way for that that is a gradual entry for the vessel. So, that is the first point effectiveness on resistance at various drafts and speeds.

Sea keeping and effect on resistance in a seaway, so sea keeping how does it affect the bulb, effect the motion characteristic of the ship, if the pitch is going to increase due to the probation because you are extending the length of the ship by providing the bulb. If the pitch increases then again you know that due to the ship motion, when we discuss the resistance in the seaway due to the motion of the ship more waves are created the resistance will be more compared to still water condition.

So, if the pitch is more or the sea keeping quality of the ship deteriotes with the probation of a bulbous bow, the added resistance increases. And hence that is going to have a negative effect if it is not a properly designed bulb. So, that is what is sea keeping and effect on resistance, so it matters a lot. Then flow to propeller and propulsion characteristics, we have seen a stern bulb you if a bulb is given its a stern bulb, the flow improves to the propeller. And if it is not provided so you do not have you will not get the advantage of the bulb.

So, that is it effects the bulb also influences the low characteristics course keeping ability and maneuverability. That is the turning performance of the ship or its ability to maintain a course depends again on the underwater form of the ship, where probation of the bulb alters underwater form and it can have a negative effect, and the directional stability or course keeping ability of the vessel. So, this is another aspect which should be looked into when a bulb is provided at the bow.

Then effect of building cost, when you provide a bulb, bulb is having a strong curvature complex curvature. Then naturally are the late preparation labor cost involved in that, will be more and cost of construction will be more for a ship when the bulb is provided. Anchor handling difficulty, say the anchor is coming in the forward region this is a bow anchors you have, so when the anchor is dropped.

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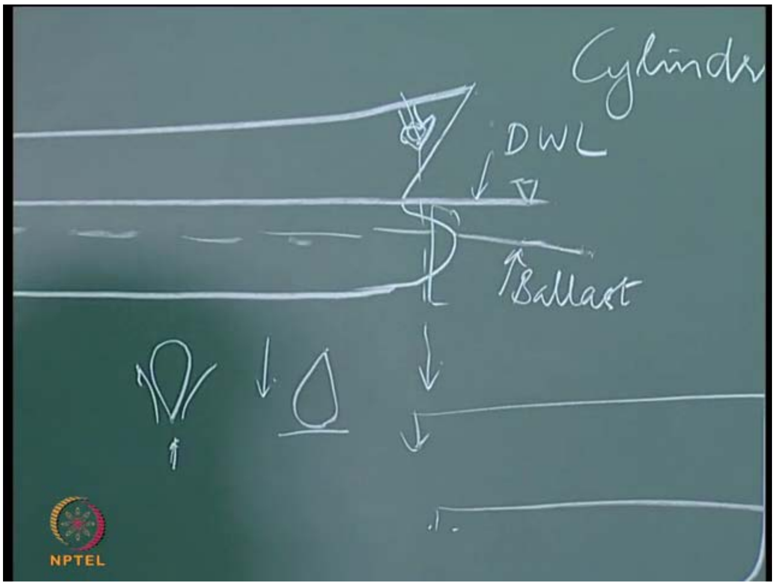

You say there is a this is a portion, where you may find there is an anchor house pipe for the anchor, anchor will be here. So, this is dropped to station the ship isn't it anchor to the bottom. So, anchor may returns depending on the size of the vessel it may be huge. So, when you lower the anchor it should not touch the bulb, the bulb is having you know the curvature like this and if this the flyer here is not sufficient that is if not giving such flyer. Then when you drop the anchor there is a chance of it hitting against the bulb.

So, anchor handling is also another problem which may encounter, when you provide a bulb for the ship. Placement of sonar dome at bow, so naval vessels they use normally sonar domes or across the scanning of the underwater, or also for the forward scanner and bottom scanners are used. So, usually they provide some times a dome as an external such an ((Refer Time: 26:02)) in mid ship region. Now, there are but problem is their will be disturbances, when you to put into it the best ways we have seen last class that the forward side is having a the laminar flow region that the disturbance is less.

So, you the vessel would like to have less disturbances, is it not? Otherwise the signals get initiated, if it is a turbulence region there will be noise created by the turbulence which will initiate the signal sound signals. So, this is another advantage you put a bow into forward and use that as a sonar dome also, that is an option there which can be considered. So, bow has an advantage if it can utilized as a, so it will get an advantage of the wave that two effects wave breaking and wave interference effect. And also it can be used for a dome space to accommodate the sonar scanners.

Length restriction in locks and docks that is a another problem, if the ship has to pass through locks, locks are provided for transferring vessel from one water level to the other water level, there are places where ship has to move from low water level to higher water level. And maybe higher water level to lower water level you know that the canals the panama canal and Suez canal panama canal in North America and in America panama and Suez canal in Egypt. So, it saves lot of time so the lot of ships take this channel for, you find that the sea level water and in between water levels are different panama canals comes through a channel and then manmade channel, then connects to a lake and it comes up.

So, water levels are different so you cannot just open isn’t it so what do you do is you put locks. So, if you want take one ship to one lock increase a water level, and then close one side make it level with next level, then move the ship to the another one and lock it here and shift it to a gradual shifting level, that is a lock purpose. We have in a lock in Kolkata port here you see that there is a lock so the size of the lock got a limitation.

And if you provide the vessel with the bulb the length of the vessel effective length increases and there may be a restriction for the vessel to get transfer to a lock, if the lock is size is small. So, that is a disadvantage so when you provide bulb are the restrictions on the lock. And also the dock, the ship has to be docked once in two years which is mandatory to clean the underwater surface, and repaint it and put to operation again to you know that is a part of maintenance for clean maintenance.

So, the docks should be able to handle this type of vessels when you add if that if suppose the l b p is two hundred meters, 5 percent maybe added to that which comes to about to 10 meter length isn't it. So, there is a action of 10 meter if the bulb is there up to 10 meters. So, this 10 meters if you increase you have to make sure at the stage of the descent, when you provide a bulb whether you face a problem for docking of it. So, that also is to be considered, so these are restrictions due to probation of bulb.

Use in ice operation generally is not preferred, but if we use go for strong bulb. The bulb is advantage of bulb is in some cases is the bulb you consider this thick layer of ice maybe one meter or more. So, bulb will go beneath that and due to the buoyancy it can come up it will break the use and make way for the ship to move towards the icy region. So, that is an advantage, but if the bulb is not properly strengthened then it will damage the bulb and it damage the ship. So, these are the process cons of probation of bulbous bow to ships.