Seakeeping and Manoeuvring

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Lecture No. # 22

Seakeeping Consideration in Design

Today, I am going to talk about as you can see the title Seakeeping considerations in design.

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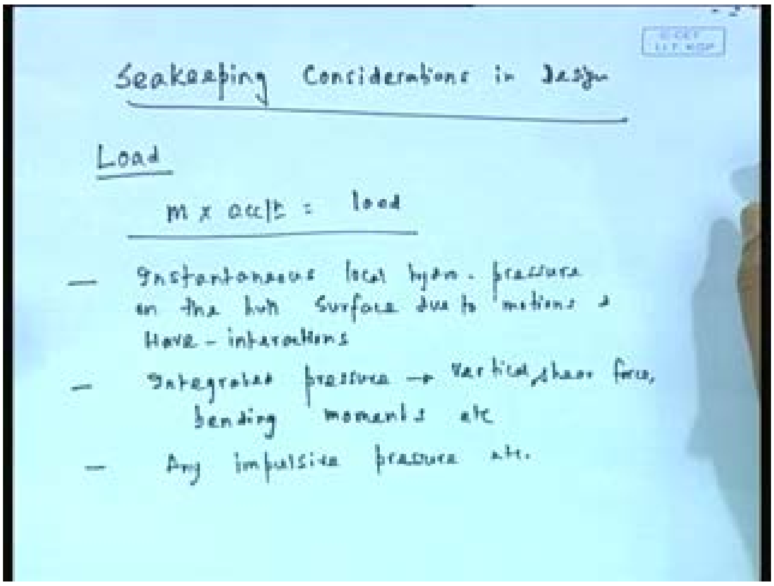

But, before I go to that, I just want to complete one more response or derived response that, I thought is important, which is actually the load part that is wave in this load, before I come to this. Now what happen, see when we calculate it ship motions, we already had load in it, because the calculation was based mass into acceleration equal to load.

However, from structural point of view quite often a structural engineer actually would like to know, what is the kind of pressure coming in the hull, what is the bending moment coming in the hull? Because, of this sea keeping, because of the motion and because of the wave in this loads.

See, the thing is that although, we had this load implicit in the equation of motion, when we did basically mass into acceleration added mass etcetera, we still want to know. What the designer may want to know is basically is this, he they he may want to know, instantaneous local pressure on the on the hull surface (No audio from 02:10 to 02:22) due to motions and wave interaction.

We have just to for completing this part because the load part is also important. You may want to know integrated pressure heaving like to (No audio 02:45 to 03:26) what I am trying to says like this, you know and we will just explain in this part little bit. See obviously, a structure engineer wants to know, what is that load, what are kind of local pressure coming on a hull surface. Because, he is going to design the scantling based on that.

You, we have done before typically wave bending moment and still water bending moment, but remember in doing that you have never consider the ship motion effects. But, here when you are doing sea keeping, already the load part have been actually used because when we did the calculation; we have mass into acceleration equal to force and we actually, when we wrote the equation of motion added mass damping exciting force are nothing but, parts of loads.

So, question is that although and then of course, (()) motion and because the section is moving there is going to be inertial load coming further. So, all this can be calculated also as a derived response at the end and I will give a simple example of how it can be done.

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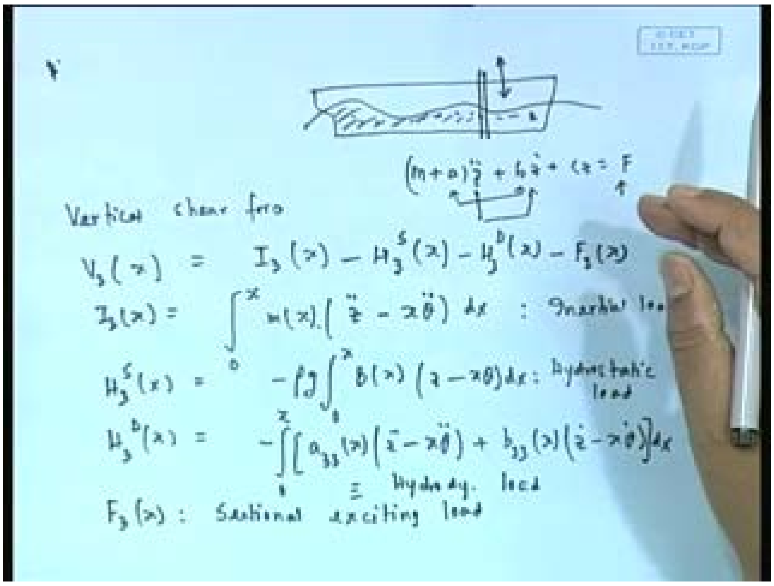

For example, you check or rather let me first draw this diagram. We take a section here remember there is wave here. This section is undergoing a motion then, because of this wave all this interaction part there are various kind of pressure. What we have done in the equation of motion is we have mass plus added mass into acceleration plus damping plus this thing equal to force. See, this was a force this was a force, all these force is already calculated inside, on top of that we calculate the motions, which also may give an inertial load.

So, what happen with all that one can actually calculate an example, you see vertical shear force V 3 x it will have a contribution from I 3 x, x being a section some some location minus H 3 S x minus H 3 D x, I will write down this minus F 3 x, where I 3 x equal to integration 0 to x, sectional mass into z dot dot minus x theta dot dot d x is inertial load. H (No audio from 06:23 to 06:41) hydrostatic restoring force (No audio from 06:42 to 07:48). Let me write it and I will explain to you.

See, what what I wrote here you know, before I go to this sea keeping I was talking just about load. See, I have this ship under water this part right. Now, what did you what did you do earlier in finding out let us say the the shear force and bending moment wave induce. You simply consider a profile a Trochoidal profile or something from one side simply took the load, sectional load to be as what rho g b weight minus buoyancy that is all that you have taken right nothing else.

But, here see in sea keeping what we are doing, I have this section remember each section, it is undergoing a motion up and down. So, this have inertial load how much now, this is undergoing an acceleration a section at location x and acceleration vertical is going to be z dot dot minus x theta dot dot; because that is our vertical velocity. So, acceleration is this, so if you integrate this mass into acceleration you get this sectional inertial force.

Now, so obviously, with the vessel is undergoing heave and pitch, so each section is undergoing a vertical acceleration, which is arising because of heave and pitch combination that is what we have done earlier is it not, Z minus x theta is the vertical displacement and therefore, acceleration with the dot dot, so you have this. Then remember, it is going up and down I have got a displacement which is given by z minus x theta into local beam, that will give me my, so called a w P into z, so called the hydrostatic restoring force additional part.

Remember it, additional part because the rest part is balanced with the mass part so, we are not taking that, this is the additional load coming because of ship motion. So, this is my additional part unbalanced between the buoyancy and the sectional buoyancy. Then, we have got this added mass and damping load, remember added mass and damping are arising, which was also a part of a load, because the ship section was moving it was radiating waves.

And that has alter the pressure field and that pressure field again act as a load. And of course, we have the exciting load because what is happening, if you look at the equation of motion here. We actually obtained the equation of motion by added mass and damping force that is given by this this part. That is e z this part, this is basically added mass and damping load arising, because of a certain pressure field created.

This was an exciting load arising, because of again a certain pressure field created because of the wave structure interaction. This was actually load arising because of the hydrostatic restoring force. So, and then of course, mass into acceleration would be, so called your inertial force, so all this can be taken. See, it is already embedded, but structural designer may want to know not only vertical shear force, then he might want to know vertical bending point it will be simply integration of this into x.

So, it can be obtained like that, so not only that you can also give him. Because each point we will know the pressure, so the entire pressure distribution also can be given. So, this is what typically we do the final part I said that, when you do sea keeping, you know there are many outputs coming up. One also want to know specially structural designer what is my wave induce bending moment, considering sea keeping, considering the motions.

And this is not what you have done earlier, if, you remember because in earlier wave bending moment calculation. In fact, there is no dynamics involve at all simply. One assume that the wave profile is stationary and we took a Trochoidal profile. The difference one can make out easily that one can make out easily that, this is; obviously, the correct thing if you have a sea keeping. And obviously, when you did the sea keeping calculation you already have all of them with it.

So, when you do sea keeping you have found out a b c f n. So, and then found the motion. Therefore, at the last stage you can again reassemble and get this answer. That is typically done, that is what I am trying to say, so this is kind of the last part. Now, I am going to come back to what I was today's last lecture and this sea keeping part is sea keeping consideration design.

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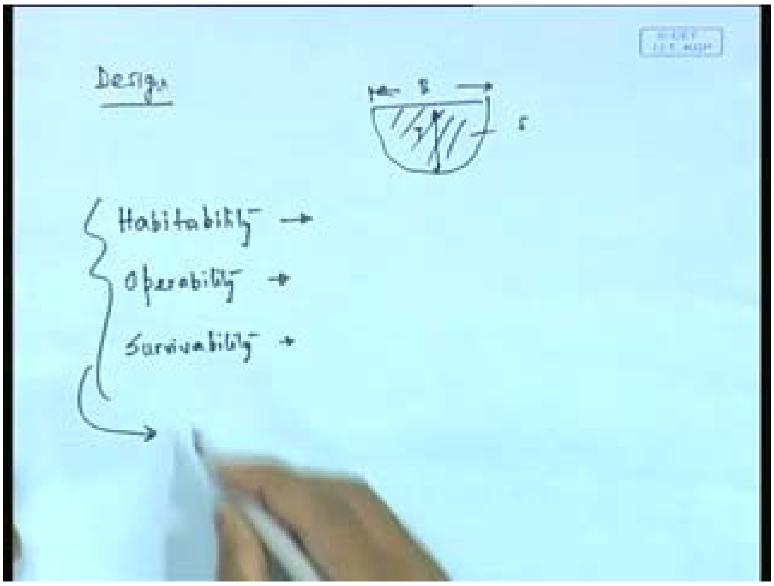

Now, you see here there is a there is an observation now that, typically you know in design people have not been paying enough attention of sea keeping. But, there is a present concerns such that this should not be so. One of the reason is because, for computing sea keeping initial stages, you really do not need to have the lines band or the hull geometry, so accurately.

All you actually require is an approximate ship for example, if I knew the section ships purely by means of local breadth, local draft and section area I can actually determine sectional added mass etcetera. What I am saying here is that in order to do elementary sea keeping calculation or initial sea keeping calculation, you do not have to have very exact hull ship. Even, if you have that anyhow you are going to make added mass damping calculation, which is in approximate.

So, therefore, there's a general consensus that it should be actually made a routine part of design. Anyhow, so having said that that there it is said because, one do not want to expect surprise after the design you find out there is some you know some characteristics you do not like. But, having said that let me tell about this considerations other, main thing that comes down is like this habitability. Of course you know, what is habitability there should be certain criteria, about certain limits of motion that make it habitable.

For example, if accelerations are exceeding certain amount you find very uncomfortable, which actually happens very quite often. Specially, if the natural pressure are low then my natural peroid are low then frequency is high. Then acceleration becomes much higher like it happens to a small boat people will always come and complain that is they are uncomfortable. Because, it is accelerating much faster, you see if natural pressure low means, what it is basically going to oscillate at a lower time. So, it will come back from this to that at a lower time, so acceleration is much faster, because it is omega square into displacement. So, habitability is concerned with various parameter.

Next comes operability which of course, is a level higher than habitability because, what happen even, if it is not very habitable your mission requirements must be met. You have a ship it has a gun mount and it is suppose to fire, now if certain motion exceeds you are not able to operate. Let us take an air craft area, you cannot taken off and land beyond certain you know like motions of the deck, so that is give an operability criteria.

You have an offshore research vessel, you cannot do an experiment lower some equipment down if there is no excessive say roll motion etcetera etcetera. Then of course, come survivability, this is of course, you know that having said that even this operator, I mean that this is related to extreme weather, well. Your design should be able to survive in certain extreme motions whether, sea storm condition certain sat sea state 7 or 8 it should survive.

So, again survive means, what it should not have certain amount of again sea keeping criteria beyond some limit. So, all this basically what I what it say is all this will translate down will write down in next one. They they are affected by this falling the parameters that affect this things are obviously, I am just writing down way to write down.

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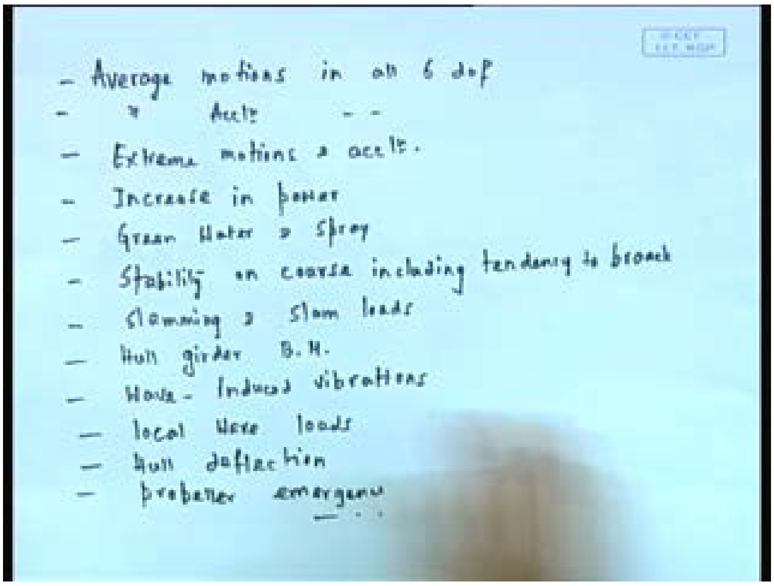

They are they are going to be well basically, you can (No audio from 16:46 to 17:15) actually we we we do know all these things. But, I think I still write for completion purpose (No audio from 17:18 to 18:59). Actually, what we wrote is that more or less all most all you see the derived responses that we talked about and more, they all effect the design in some sense. Now, the question you see this is all you think you will be able to understand that not all effect equally, it all depends on the kind of design, kind of mission requirement etcetera, etcetera.

Here come the question, you know that what is happening is that most of the design now we are talking about the design, you have to have a specification. That it should not exceed this, it should not exceed this etcetera, etcetera; how do I have this specification. There is no uniform rule for that, I just two examples, but let me give one example first.

That you see one example for example, of this criteria is given like that just just to have an understanding.

Once again I am telling that these are the factors that effect, what is that what we require, we require to now access a design or consider sea keeping aspects in design, even in the initial stages let us see. So, I must have a criteria specify that look my design should not exceed, so, and so, and so, and so etcetera. Some criteria acceleration must not be more than say 0.2 g etcetera.

This criteria of course, there is no uniform basis, which is what I am trying to say, that depends on the mission requirements, that depends on the percent, there is no rule right now. Because, habitability, etcetera cannot be made a rule, you might find comfortable up to you know certain acceleration, another person may not be. A cruise ship might have different habitability criteria compare to a naval ship.

So, having say that, there are some criteria of response that you have to establish and then find out, how I can access a design. So, this typical criteria might look like that, this is a criteria for a naval ship, for helicopter operation (No audio from 20:57 to 20:10).

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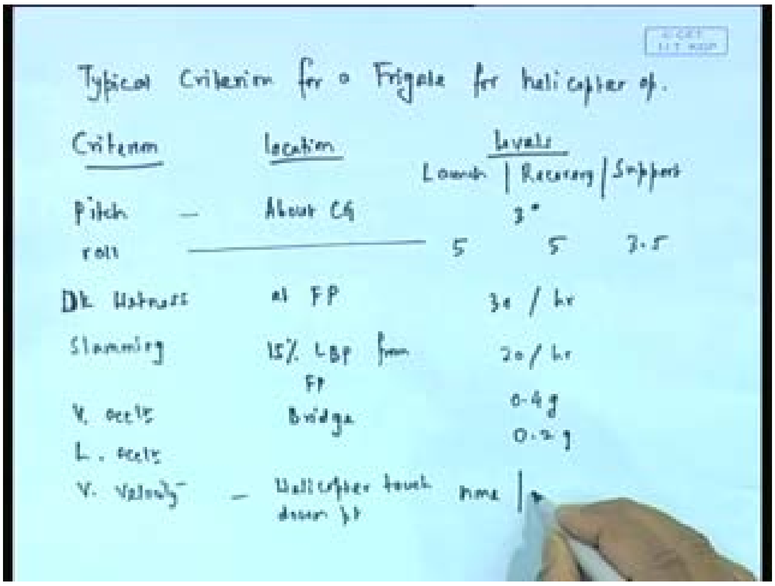

Say for a frigate (No audio from 21:11 to 20), so it may look like the criteria, location just to give an idea. Here say pitch it says, it may look like that location, here they have got a different level in this case launch recovery just to give an idea you know support.

This it says for all of them 3 degree say roll this, for roll it says for launch it is 5 degree recovery 5 degree, support 3.5 degree. Then deck wetness, where at F P, what is this 30 per hour maximum slamming.

This is deck wet, I will give an right example 15 percent L B P from that is force foot 15 percent beyond 20 per hour. Then vertical acceleration, it says where at bridge, so 0.4 g, lateral acceleration, same place 0.2 g, vertical velocity, where at helicopter point, touchdown point. It says launch time is none, this recovery time is 2 meter second and support time is none.

See, what I am saying you know this kind of table, you have to one has to make or a designer has to, when you are designing it, the owner has to specify, that for my ship I want this criteria. See, that two things we will talk about, one is this the criteria that is given, now what you do, what one has to do is therefore, after that, calculate at all possible sea state or if the environment is given at those sea states.

The characteristic from sea keeping then irregular sea keeping calculations, all these values say when they say pitch not exceeding 3, he will actually be mentioning significant pitch or average pitch some value of pitch in a sea state. Then having done then one makes what is call a polar plot, that is the main interesting thing. So, you will calculate for various sea state, for different sea state one will calculate all his criteria know that you, for example only find out how many times slam occurs.

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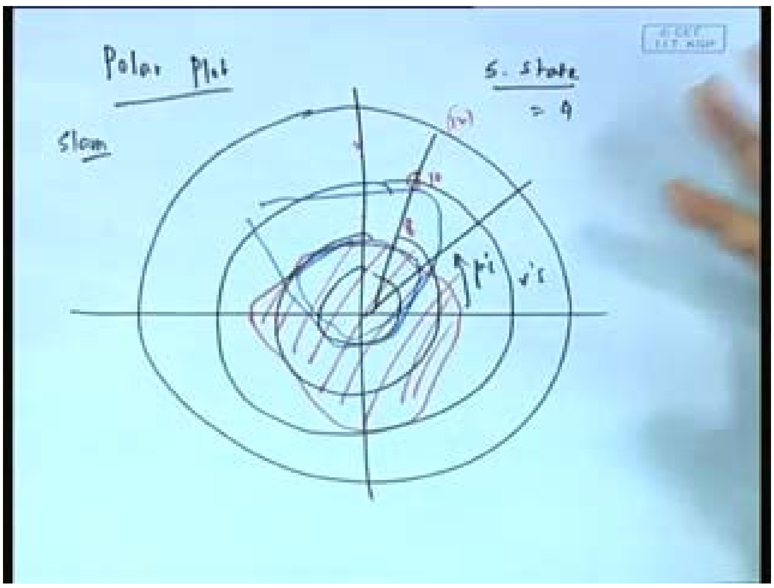

Then we make a polar plot, now polar plot look like that, there is a circle here for order of merit. So, we have here various speeds actually, it is a radial part of v verses theta. So, these are various v's and these are various mu's or heading's. What you do is that, people will find out see, let us take an example (Refer Slide Time: 25:04) bottom slamming at a given location should exceed 20 per hour. Now, you find out this is for a given sea state, say sea state equal to say 4, some sea state you have to repeat that for a different sea state and this for a particular say response slamming.

So, what you find out is that say this slamming 20, it does not there is a boundary there. If the waves are this is actually say 0 degree here and this is 180 degree here this is, what rather you you start from 0, 90, 180 like that this is an angle you can make out. It turns out that say, let us say something like that, it is this region, that is this combination of v and mu if the ship is within that, then my slamming become less than 20 per hour.

In other words supposing my ship speed was say, this was actually 6 naught or 8 naught, 10 naught, 12 naught. So, if it is say 10 naught this angle is whatever and then I will find out my slamming is more than 20. So, this gives me an area; that means, over this operation zone up to now operation zone is defined maximum speed is say 12 naught is here. So, I have this circle as operation area right. Now, I find out in that only in this area essentially my slamming is within the limit, design limit whatever was specified.

So, this was one criteria now you will have for sea step 3, what you have to do is put on that or other criteria see another criteria roll for example, it may be some other area. Then, what happen that two are combined only in this area, which is a common area to it, that means only in this area either both roll will be less than 5 degree and whatever or slam will be less than 20 per hour.

So, this kind of plot, now having done that all you find a common area, so this common area as a percentage of the total area would keep me the merit. That means, the merit of the design for that sea state it is, so much percentage; that means, so much percentage of time that, you can say performance index. That means in sea state 4 my operation criteria would be satisfied let us x percent of time or a that is the not not time really that is the order of merit x percentage keeps your order of merit.

See I give you an example here actual example of a ship that, we carried out in sea state 5, 3 and 5. So, here let me just read this from this I do not know, I will just write it down that. So, see here a particular ship that, we carried out where the parameters are given like that.

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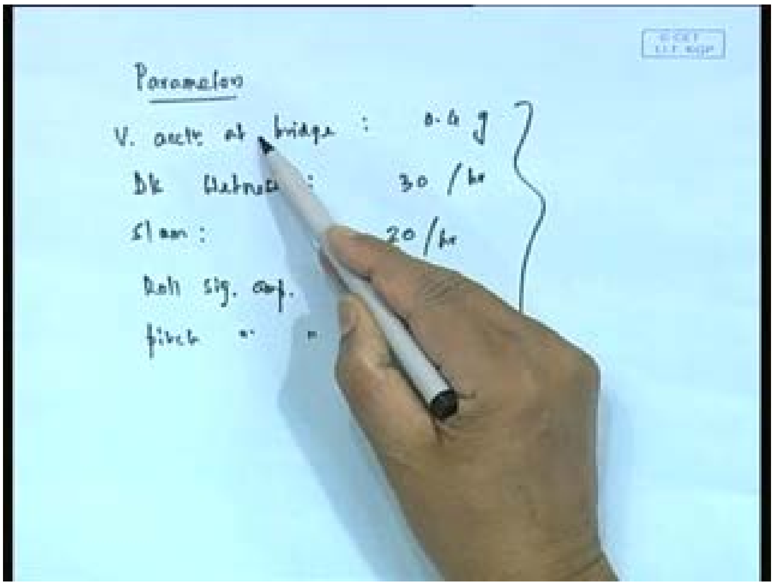

It says vertical acceleration at bridge 0.4 g, deck wetness 30 per hour, slamming 20 almost same thing, roll significant amplitude is 10 degree, pitch this of course, sounds very high. But, actual ship data, I am telling this people have sense like this excuse me. Remember one thing that it is not necessary to include all the parameters that we have mentioned earlier, see in sea keeping parameter can be large number, which we have mentioned earlier like this all are not necessary to be mentioned.

You know an operability index or whatever the criteria may be specified for you, but typically you will see common thing. Vertical acceleration, slamming, deck wetness, roll and pitch this normally become a very important criteria. Most of the design will give actually this, vertical acceleration become very important for a defense kind of craft, they will also limit vertical acceleration at the equipment location. Because if you know where the gun mount, if it accelerated it undergoes very high load you may not able to operate something.

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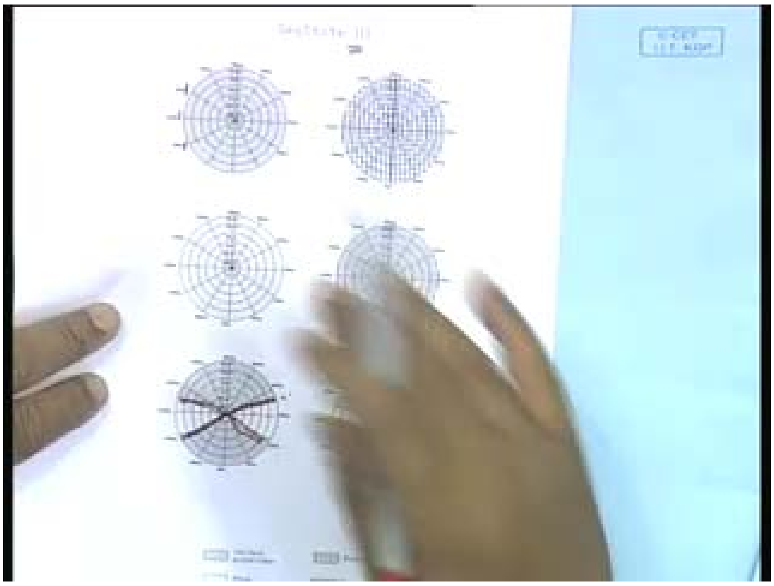

Now, having said that see there is a this design, I may be little bit you want to see that what see this was, this is the different just for example, I am giving polar plot for different criteria. The first one is shows the full hat means that in sea state 3, this was for sea state 3. I am just trying to give an example, vertical acceleration entire zone is operable no problem, then my entire zone my vertical acceleration is coming more than this thing.

Similarly, slam per hour in this case entire one is operable actually all this excepting, what we are getting is this one roll. It turns out a roll you can operate at this region excepting this white. See, remember it is interesting this regions are actually beams region, that means, when the waves are coming from the site beam naturally there you expect much much more roll.

So, in this see in this is only sea state 3 very low sea state, so it can operate excepting when it is within this means, when it is 90 degree ninety plus minus say 10 degree and so, probably it looks like here 100 degree to something like 60 degree. For whatever the amplitude and similarly, here that is all. And now when you combine all that all that, when you combine put them all together the combine operable region become this.

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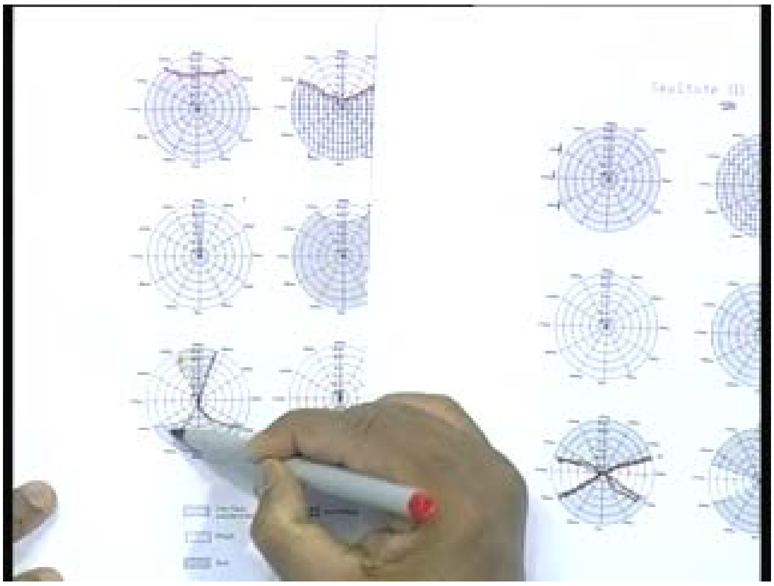

So, here what happen, if hash part by this part will probably becomes something like 70 percent. So, 70 percent of the combine v and mu I am able to operate. But, now this is sea state 3, go to sea state 4, 5 immediately big difference, see here if I have to plot set these two together, this one is vertical acceleration. Now, my vertical acceleration here sea state 3, I had entire part. But, sea state 5 you may I find that this much I cannot operate, what is this, very high speed at head wave condition not able to operate.

Next one, here I cannot operate over this region that is this is actually slam per hour, too much of slam is here. This pitch no problem 5 degree actually too large a pitch, but deck wetness same thing I cannot operate. Then more interestingly roll this big area I cannot operate. So, when I combine that all that two together, you see for this particular sea state it turns out I can only operate it in this range. The entire range I cannot operate, because it actually does not satisfy the criteria. That means in sea state 5 such a rough weather only following condition I can have.

So, now this gives me a order of merit for individual sea state now what is the next step. The next step is also interesting, what you do now we know the ship going to go to a given area.

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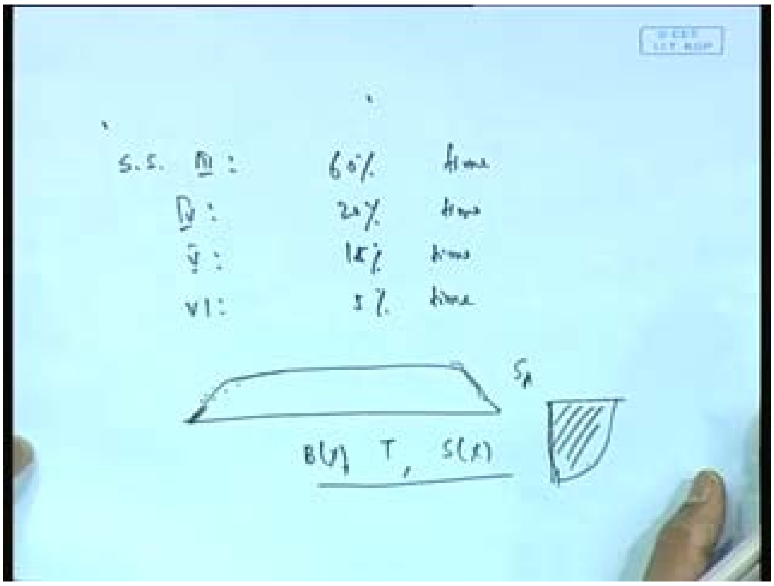

So, I know that this is operating from a to b and I know here the sea state 3 occurs 60 percent of time, 4 occurs say 20 percent of time, 5 occurs say 10 well 15 percent of time and say 6 occurs 5 percent of time. So, what I do I simply multiply those factor with that point 6 into 0.7. So, I end up getting an overall merit of the design based on this this is exactly what is done for evaluating a design. You see, but; obviously, what you do what one can do is that typically in in a design of sea keeping, you cannot design the ship to make sure that, this roll is going to be 4 degree.

What you do is that, you can only do a design, for too many parameters are involved and find out having done the particular design what is it is performance criteria finally. So, the point is that initially you can iterate the design, if I have design tool available. As I said I do not required that geometry fully all, I require is see when you are doing a lines band. If you recall you end up actually making a section area graph S A graph and you end up getting another one, what you call this is water plane area of graph right.

Essentially you will be knowing each section in a design local breadth B x local draft, which of course, become typically becomes draft and section area. This three parameters normally you are drawing a section shape. In fact, with these three parameters only one can estimate using limits from another form added and damping. And then there are programs like strip Cheryl programs available by which you can estimate R A O’S

Now, once you have R A O, of course, you can always go to the algebraic process of determining response in irregular waves. So, therefore, at the design stage I have done a design in one of the loop and at that particular loop point when I have chosen this, I can easily do the sea keeping calculation and find out the entire criteria. So, you know what I am saying therefore, is that it can be easily done, the only problem, of course, is that you have to have a sea keeping kind of program tool available with you and should be able to run it.

Now, that is what is not always very simple, because the common tools are like stiff theory matters etcetera. They are not you know like you cannot do them in a in a calculator tables of calculator. It is a program, that you must have many of the design design what I should say programs design suits are having sea keeping program as a part of it; so, this is one part of the design. Now as I said before hand there is no fixed rule regarding what is acceptable etcetera.

But, some critical formulas have been suggested by some people in a broad sense to evaluate design. One of them, I just mention is called Bales criteria to or Bales sea keeping rank. As I said, once again there is no uniformly accepted standard or empirical formula to tell what is a design with good sea keeping characteristic or some numerical measure.

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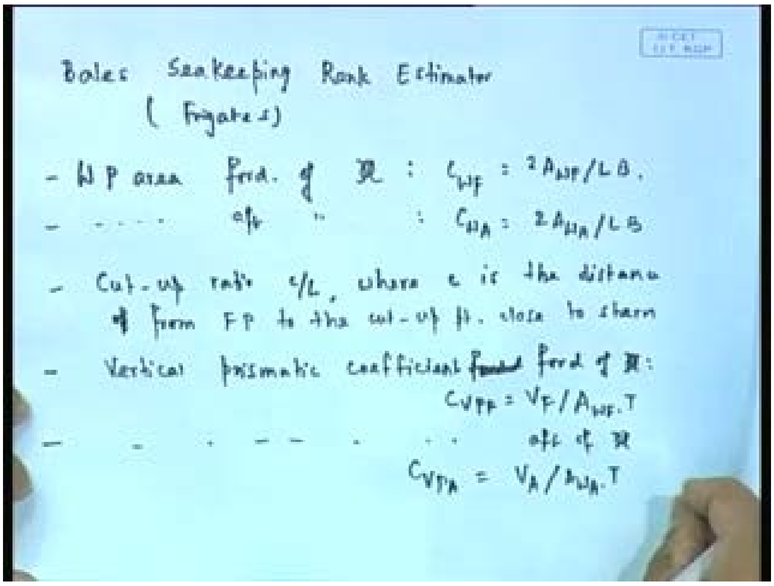

But, some have been suggested one of them is in a personate design is I want to mention here bales is the very crude way of actually telling sea keeping rank estimator. There is a (No audio from 36:35 to 36:45) applied for naval hull, what it does is that they they heave presumes. And it has been found, that sea keeping depends on only a few parameters, one is water plane area forward of C W F, L into B. One is water plane area after of mid ship.

Now this is a new word cut up ratio, actually this is typical point in a hull, that is defined c by L, where (No audio from 37:44 to 37:57) this is actually close to (No audio from 37:58 to 38:14) this is a point defined in a particular, you know like in different vessel (No audio from 38:18 to 38:50). C V P F equal to V F by A W F T, similarly this after of.. (No audio from 39:08 to 39:19). So with that, with this parameter actually this is just, you can see that he just come up with a formula, which says like that it is very simple formula.

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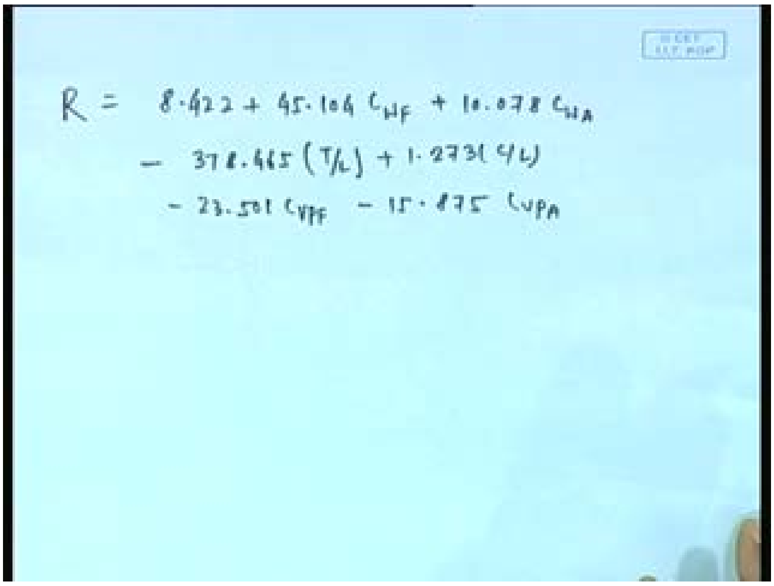

This is only to give you an idea regarding that there are some formulas available it says (No audio from 39:32 to 40:08). See this is only to give you a rough idea really speaking it us not very like important, it is a very crude rough idea to evaluate rank what it means you know, I will tell you. Supposing you are doing a initial design, so you are changing parameters. So, you have two kind of comb, now you want to rank them which one is better compare to which one.

You can use such empirical formula to tell that will this is going to be slightly better because, it will have a larger art slightly higher rank compare to the other as per as sea keeping is concerned. So, this is there are some similar formulas available, but it is recommended that one do not use it as such if you have a tool of computing sea keeping at hand. And at today at 2010, this time every ship yard or everywhere you go for design, you should have in the design spiral a good sea keeping estimator based on stiff theory or something.

And then of course, many having said that this gives you an overall idea. But, there are many other parameters also that may be important I will see, what we said here is that you have done a design then, how you kind of seeing is performance. But, we if I will just talk in next few minutes only on as a designer a feeling about which design parameter effects, which sea keeping criteria and which comb. That means, if I increase length do I get a better heave motion, lower heave motion etcetera.

That is effect of different parameters on certain responses that will give an idea, because that may for example, shape forward should I make a V shape, should I make a U shape, should I make a oval shape, which is good. See here of course, the detail shape has not being mentioned I will just mention briefly that part, very briefly you know length, breadth and all this part because we really cannot tell, so much.

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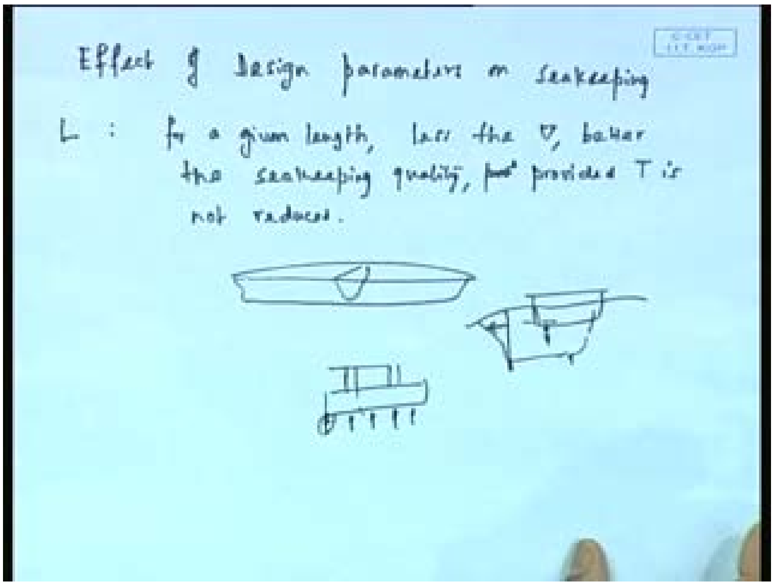

Now, effect of here (No audio from 42:08 to 42:37) length just broadly (No audio from 42:42 to 43:25). See very simple slicker form, longer and slicker form; obviously, when you say for a given displacement, for a given length less displacement, which means what final form. Obviously making it longer, but not too shallow it is also obvious, you see if you you know like I can you can just think intuitively, if you have a shallow draft vessel now wave effects, wave forces.

See, if you look at this this vessel wave you know it goes like that the parameters the the wave effects go like parabolic. Now, if you say that the effect the load that comes at this level is of this magnitude, but if you have a deeper vessel, you will have a much smaller. So, the exciting force that tries to push it up and down which causing you pitch and heave is going to be less. In fact, in fact, one of the reason of semi-submersible has been that you bring down this buoyancy part lower and lower.

If you do it lower, the exciting force that comes on that is less because you know, as you go further deeper down in water, the wave kinematics reduces, wave kinematics is all exponentially reducing. So, if you consider a point here the wave acceleration which of course, after all decide the kind of force acting on that is going to be small. So, deeper draft vessel will; obviously, expect less excitation in vertical plane. Now, here in lengthwise sea keeping it turns out that if you make it longer and finer. But, that the do not make it too shallow draft you have a overall better sea keeping criteria.

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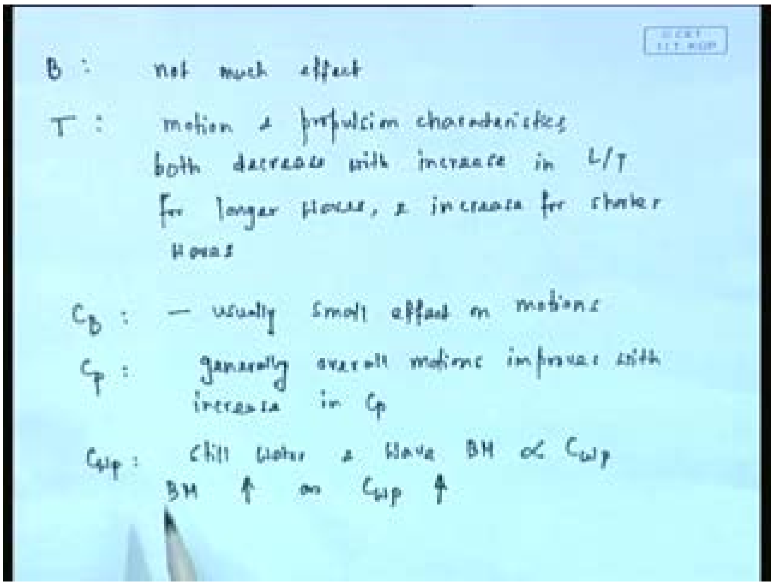

Now, like that we can keep going, beam not much effect there is some effect, but we are not going to go this things draft tree (No audio from 45:35 to 46:18). Now, this is actually (No audio from 46:20 to 46:44), these are general observation you know actually, what I want to write is more then block coefficient (No audio from 46:57 to 48:07). See this water plane (No audio from 48:09 to 48:26) the water plane area effects primarily the bending moment or that make sense basically.

Because, in water plane area come down you have a much restoring force with the larger bending moment comes out. Now, the other thing is free board and this is important (No audio from 48:41 to 48:55).

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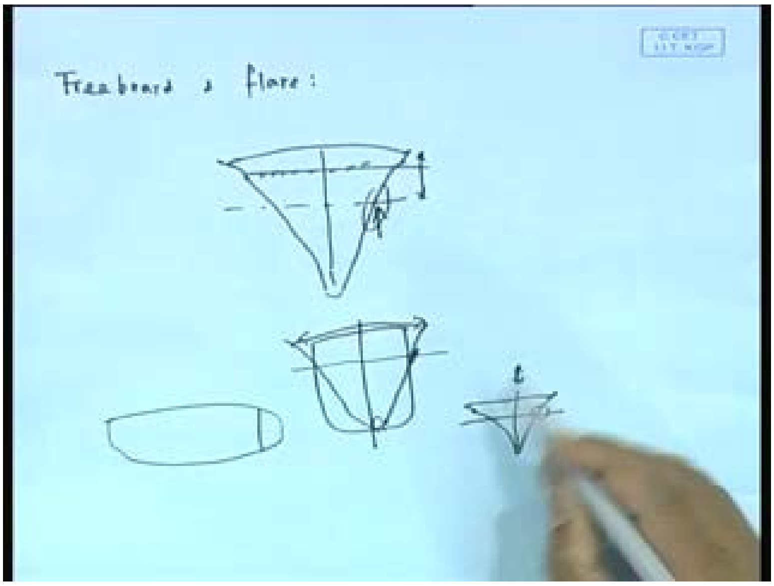

Now, this part you see here forward part should you keep large flare, like may be the deck here or should you keep smaller flare. Now, is the point is that you see this flare increase in flare, normally will increase the slamming that obvious you know specially this flare slamming, what they call slam at this this this region. This is also connected to your, so called you know like U shape and V shape.

On the other hand the point is that free board, by itself do not have much effect, generally as far as the section ship is concerned. So, what is happening is that this is actually the question of, you know like judicious choice should you take typically the U shape and slightly V shape has their competing effects in V shape the slamming is larger. Basically, bow flare slamming is larger, but bottom slamming is smaller. U shape the bottom slamming is larger, there is no bow flare slamming, bow flare slamming means slamming coming at this this region.

Now, the question that comes is that, how do I choose that that that depends on it comes out from other design consideration. So, there is no really hard and fast rule that, you cannot you can tell now very nice example was given here that, I wanted just to mention. That suppose, you have to do a aircraft area design. Now, a aircraft carrier small size, you want to have large deck area, because of the large you know.

Now, if you have large deck area you are looking at larger flare, if you want to have large flare, then you must find out whether. In fact, you will find aircraft area in a large flare, but if you have large flare, then you must make sure that the ship has lower vertical motions because if so, they are going to have a large you know like slamming here. So, therefore, it is a question of kind of combination bottom flare you can afford to have large provided the vertical accelerations are small, because it is a small then load is going to be small.

In other words, if I have to tell the looks flare that necessarily increasing slamming that is not true, because that depends on the motion itself. Now, if you have a load then the motion is somewhat low. So, therefore, all these criteria's are you know like, as I said there is no hard and fast rule. What it comes down is that most important factors therefore, is basically length, beam is not, so important, but draft is important. Because, if you have a very shallow draft here that motion, forward section becomes somewhat important for deck witness and slamming point of view.

Water plane coefficient is important from bending moment point of view, block coefficient is not very much important. So, more or less one knows, what are the parameters, but the most important is all of them, is to ensure that you have a natural period that is not very much close to the resonance. And to make sure that your pitch and heave natural period do not coincide close by. You want to have a separation, because we have seen earlier that the natural periods for a typical ships are very much in the vicinity of typical wave that exist.

So, therefore, one of the important point was to ensure, even if you space them by 2 second or 1 and a half second that is good enough. But, it should not be like natural heave and pitch period should not be between within 0.25 second that is one point. Then just another 1 minute, I mean this is the last class for as per as sea keeping part is concerned, I just want to tell you one more thing that, yesterday we talk about you like like speed loss.

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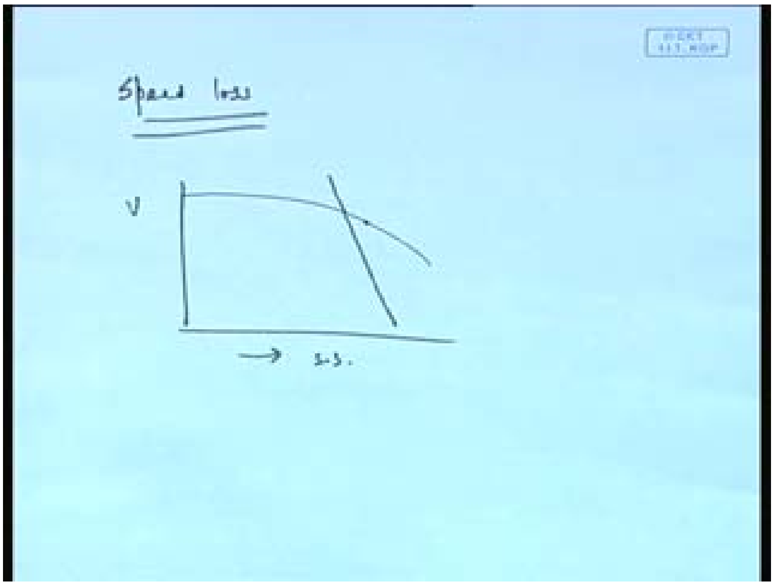

One more thing that the captains quite often do when one travels in ocean, see we have seen that the the there is a speed here, v here. Basically it comes down in various sea state with respect to you know sea step here. But, point is that sometimes is just the last part is that sometime the captain has to deliberately lower the speed, because it might be having excessive some you know motions.

So, it he might have a cut off somewhere that means, although the lost is here what is called voluntary speed loss he has to deliberately use the speed because if, you did not use end up finding that it is slamming excessively. So, therefore, obviously, you do not want to do that, but this what is known as voluntary speed reduction. That means you deliberately reduce the speed otherwise you finding out that, you are having very excessive motion.

So, this is also another part you know like sea keeping which is important, when actually you are going on a rough sea. With that actually I am going to close this part; that means, sea keeping otherwise is a very large topic, but we have only limited hours. So, with this in the present lecture, the sea keeping part of this course is over and next hour we are going to spend on maneuvering, we will start maneuvering from next hour. So, with that I close this.