Seakeeping and Manoeuvring

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Lecture No. # 31

Definitive Manoeuvres – III

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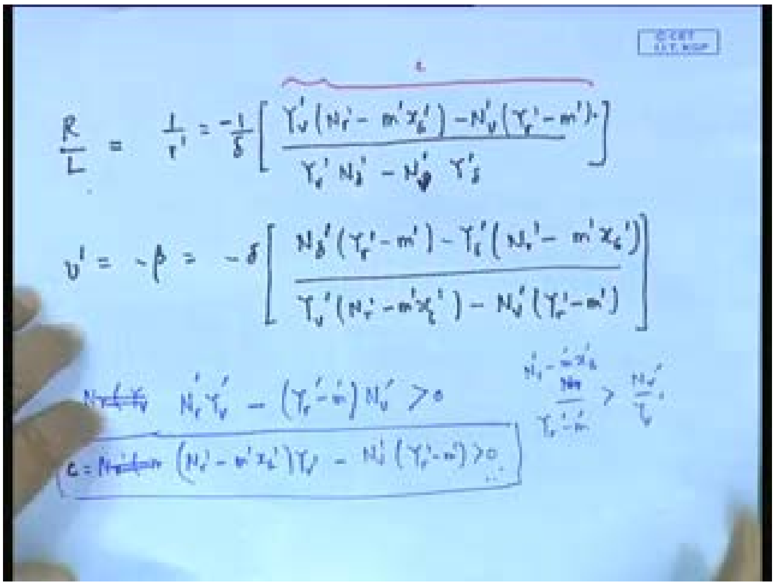

See, we will continue our discussion on the turning manoeuvre, I will bring back the you know last slide of my last lecture, what I was trying to mention that you see in the last class, we found out that in a turning manoeuvre my R by L, when R is the steady turning radius L is of course, ship length is given by this expression, and the drift angle minus beta given by this expression. See what therefore, we are trying to tell is that if I look at this first expression you will find out that from expression this top part is actually the c, this c that is the stability index now for a stable ship this c is supposed to be positive. If you take this into account you will find out that R is inversely proportional to delta and also if I take the proper signs you will find out that it will always turn, if I were to give a negative ship will always turn this side.

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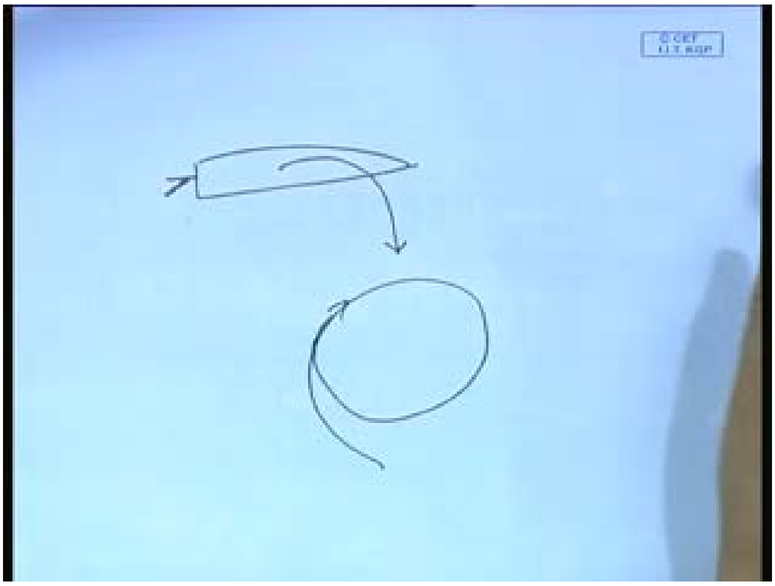

So, this two will find out that is the direction of turn etcetera because we can put this proper sign, I will leave that as I said to you for to you for exercise from the signs, from the signs of various terms etcetera the other thing you find out is that R by L is independent of speed this is something that people never realize this in at least within this linear theory why? Because there is no scope of v coming that the speed coming you see this terms are all independent of speed ship speed. If I were to make dimensional also then it will be all half rho l v square etcetera, all will get you can check yourself it will all get deducted you know like cancel from both sides, so interestingly therefore, the ship going at 10 knots at 20 knots at 30 knots if you give 30 degree R R it is going to have a same turning radius what differs? You know what differs; basically the time taken is differed.

The time that it takes to execute become much faster because it is going at a much faster speed but, the circle will remain same that means if I were to do a simulation, I will find that this will remain like that only just that it will become faster that is 0.1, 0.2 is also with respect to the drift angle, you see the drift angle also I leave it to you, you will find that the drift is indirect proportional to delta which means that if I give larger radar, I have larger g that makes it very interesting point.

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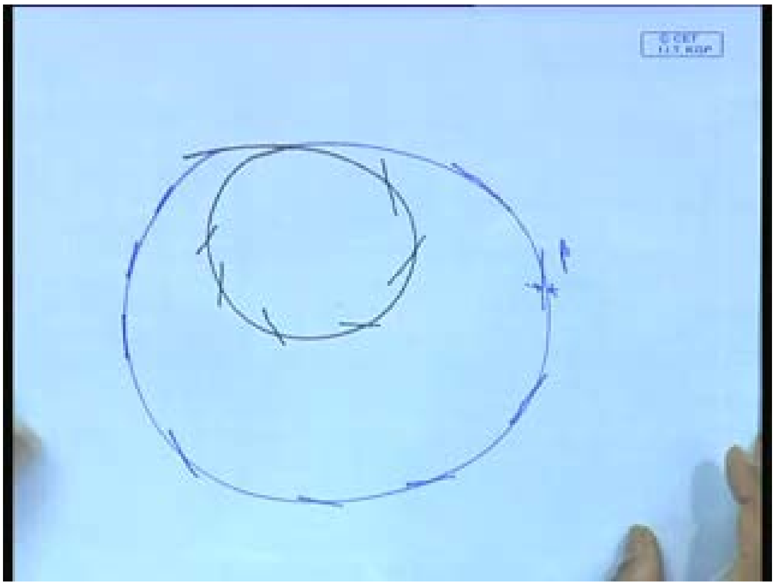

That means if I give larger radar then what happen the ship turns at a quicker turn with a larger drift angle and if it is a smaller radar and drift angle is smaller. So, this is also very interesting because if I want a larger term, then it turns out that I have a larger drift angle in fact this read, now you know you will find out interestingly that this drift angle beta if radius is made infinity then beta becomes zero, which basically means beta can only become zero, when it goes on a straight line because R infinity is a straight line, but if you were to turn you have to have a beta that the point is very taken you cannot have a ship turning exactly like this, you just cannot have; beta is a necessary condition the existence of beta for a ship to have turned, you can see it from there that is these are all interesting consequence of that.

What happens when the c is negative in fact, if c is negative this part becomes negative. So, you have no definition because when c is negative you will find out this solution to on hold good and in fact, if you see R by L part you will find that you are doing opposite within a limit of course, it is not very true but, if this is negative exactly you know full opposite side it is going to be basically ship will turn. So, of course that is not cannot be stretched much because this part become denominator here becomes you know zero and it becomes infinity but, this observations are very interesting. Now, we will look into this behavior part of why initially the ship has turned on this side and what are the heal along with that.

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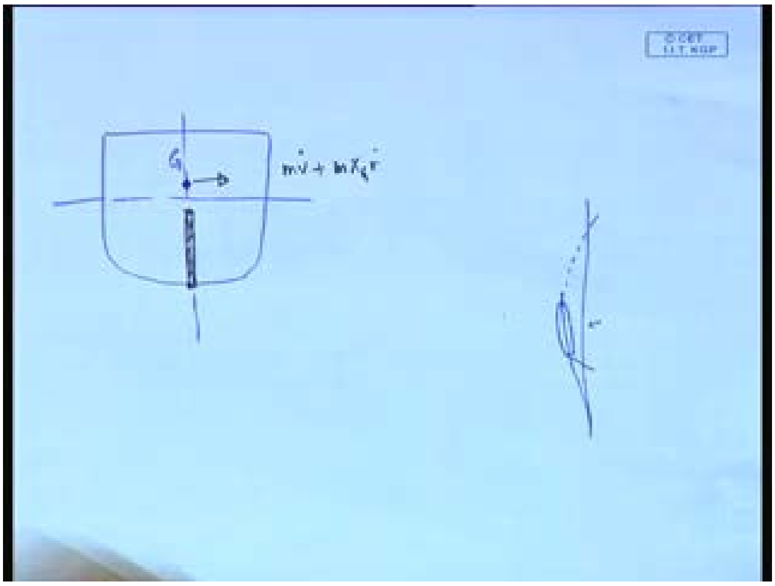

Let us look at that part, see initially I mention that as a ship goes it basically goes this way in the first phase, approach phase it has actually gone to this side even though I have given radar here why? Let us look at this pictures of the hull see this center gravity here this water line, let us say radar will be somewhere here typically radars are here no, so we end up getting a force here.

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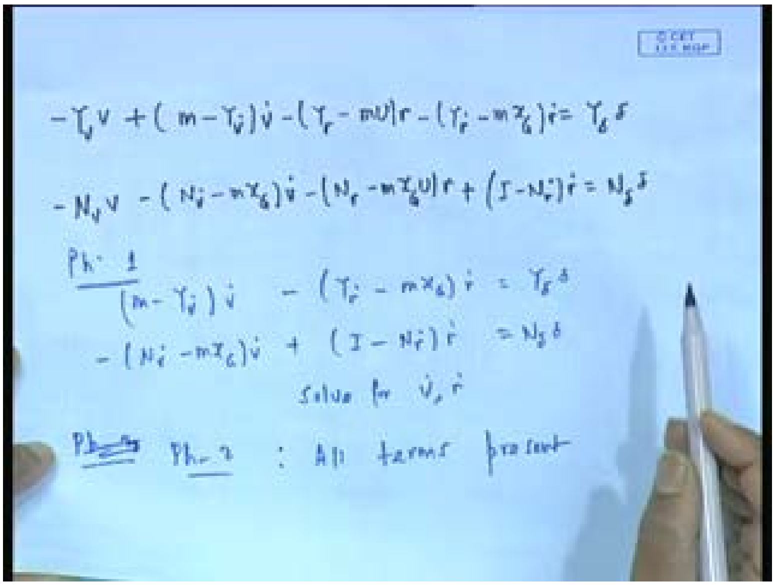

That is m v dot plus m x G r dot in fact, this will come out from this equation of motion you will find out m v dot and m x G r dot, this two actually comes out these two equations you are not come let me put it on this one or let us, let me see this from this the old equation one, I just want to show you why this or rather just give me a second I will locate this and see here.

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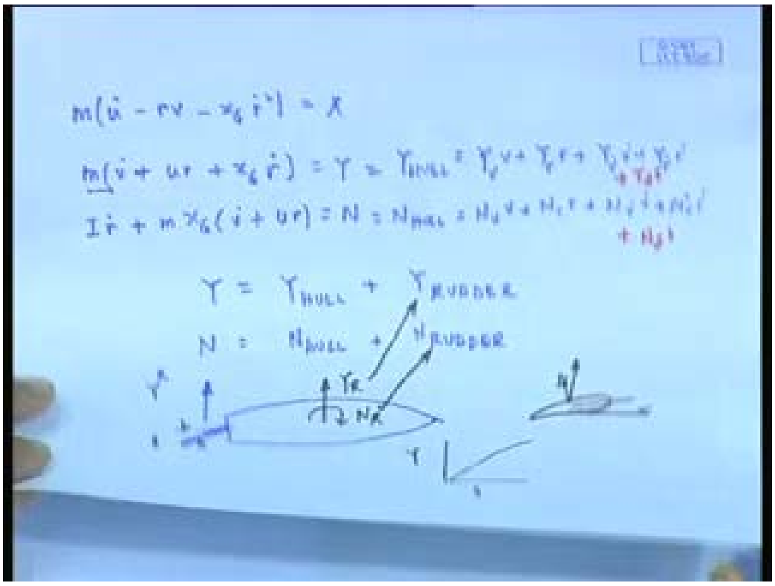

This is my old equation that I had in last lecture, and if you find this inertia forces you know you have got m v dot and m x G r dot and m u r etcetera. These are the term that is, that are coming then for acceleration this is m v dot and f g m x G r dot this actually the centripetal acceleration force basically that is what is happening say, this is there that one now the thing is that why I am writing this is because this when you are actually accelerating and of course, you are actually also have here this side you know that m into u r this is other term.

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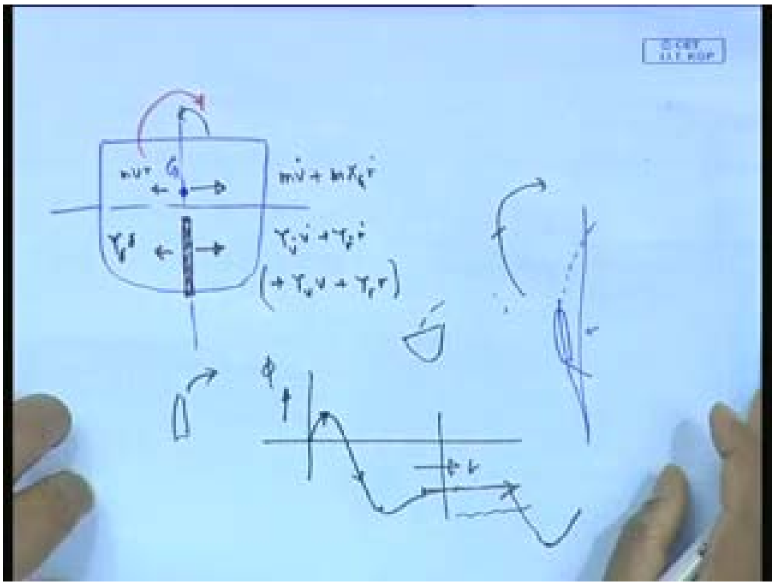

That is this if you look at that you will find out that depending on the sign and all that I will just leave it and here the hull forces come Y v dot v dot, plus Y r dot r dot, plus Y v v, plus Y r r and this side comes the Y delta basically these are the forces, balancing of the forces you know there is there is a what you call m v square by r force that will come that is this one m v square by r etcetera as it is turning here on the right hand side

So, there is a force coming on the outside remember this is turning on inward this vessel here is turning this way. We are looking at the cross section point now what happens see initial phases what is happening is that I gave a large Y d delta, delta initially because I just apply the radar my v dot and r dot are small values, actually Y v dot Y r dot is typically smaller than this and this force represent as smaller than this normally. What happen although I gave that first I gave push on this side, before the hull could react the hull has got shifted this side, see before this is the thing no I give a push this side, as I give a push this side before it could turn it actually got pushed this side and then of course, going the heading will turn, so this is why at the initial stages because of this Y delta the ship moves this side.

Not only that if I were to take moment about this point, this forces are very small which side the healing moment will come? It will actually turn out to be this way the healing moment will turn out in this case in the first phase to be something like this way ship is turning that side, so what will happen it is going to turn inwards to inwards to the circle, inwards to the circle. So, this is gone now we will look at the third phase in the or well let me look at third and then come back to second. In third phase what happens this has now fully established this term remember but, this is not there but this is there now this hull force this part is actually much larger than this typically this hull force, this as a result my force is more net force. I will establish this relation we will even do a problem this part of that force in the third phase is larger than this part which means there is a net force on this side.

Then what happen, the net moment is on the other side so the ship turns on the other side but before that that means let me put it this way initially if I see with time initially my heal, so let me call inward is plus so I have actually slightly plus but then finally, I have got steady minus because this possess become more but, in between that when both of them are there, this part was my larger, because when this also is present with respect to this then my this side moment is even larger than having only this part that means this is actually larger. So, what would happen it basically would have shot it here and then come down to like that, this is how it will look like the healing that is phase two I would have actually over shot the heal and then ultimately got back that, so this is how the heal will look like. So, this is very and you will find the picture always that the ship is you know there is a classical picture of aircraft carrier you know I have on my table you will see.

There is a turning is outward that means if you fall from the deck or a aircraft fall it will be the outside the loop, see if you are turning here the slope is this way, so you will fall outside for a ship, not inside when you are turning you will find you, you are turning away I told you with like this way orientation you are turning. The interesting point here is that see this I will also explain but, from physical you can understand now suppose you are turning, you are here you are turning we are outward. Now, suddenly the captain decides that I am going to stop the radar bring the radar to zero quickly what would happen you know? Remember the net force acting here is this minus that which gives me the moment, see once again this minus this gives me the moment which gives me healing.

Now, suddenly I make this as zero what would happen, this is actually become suddenly more, so it is basically going to have a snap roll outside, it is going to actually certainly go further rolling instantly and therefore, it may capsize see you can I will show this now with respect to a kind of equation form but, this I want you to see the physics of it basically, what I am saying is that see or rather let me show it in another diagram with respect to this way just that part of the force.

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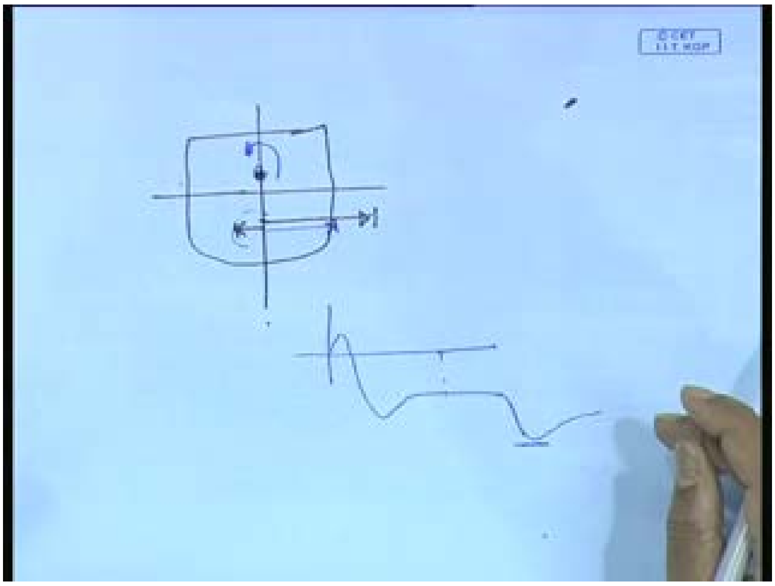

Never mind the G force, because we are taking moment about the G line always, see here, I had, here I had I am just looking this forces at see there I have a force here this side, and I have more or less the force there this side this radar force. This is radar, this is hull, so this net force gives me obviously approximately, I will work this out something like this that is a net force this about this gives a moment agreed.

Now, what happened? Suddenly you bring this to zero suddenly, not slowly you know we are talking of this time element then suddenly this much of force will act that means the moment acting here to turn is suddenly increased therefore, the ship is going to have a snap roll and eventually it may this thing but this may this what is call snap roll it might be more than you know like stability angle, so it might actually capsize. So, this is always bit dangerous you know, this part is always bit dangerous that is why when you are kind of turning steadily you should not bring the radar to zero on very quickly you must bring it very slowly and I tell you many small boat that capsizes it is not only the static stability loss, it is also because during turn there is a heal and dynamic effects.

Radar forces come in plane many capsize actually occurs small boats actually during turn you know because during turn there is a tendency just imagine that also, that if you are turning and you are going healing outward and then everybody also moves outward then there is a further shift of it outward then, there you know free surface effect water moving to this side, so that causes further augmentation or the when you are turning because you are moving outward. So, this is an important point that when we talk, even you know safety during turn the heal becomes very important but, we will find out that the for the large ships the heals are very small angles. Let us now work out how do we like you know calculate heal angle during steady roll.

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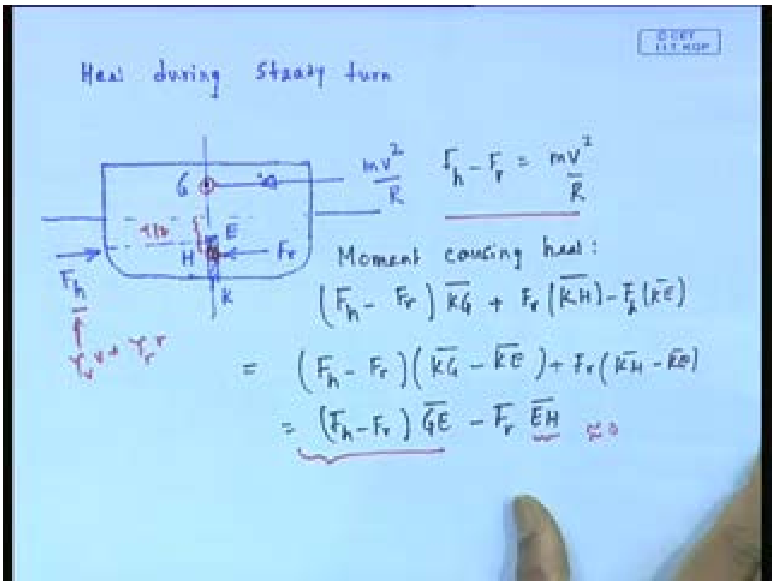

Let us go in this way; now steady turn let us look at this I will do it in a simple way and then we also draw a do a problem.

This is radar, mv square this is a centrifugal force there is basically m u r if you look at that it will become like that m u square by this square by R or whatever. Let us call this with a hull force F h acting at a point E, let us call this F radar acting at a point H and this is a point K, see what we are drawing here is something like this I will explain there. This is my center of gravity we will of course, take the moment about that, so we do not really so much care but we will have to have this is all during steady turn, remember that dot part which I thought earlier is not there remember this forces are not there, this is not there, this is not there because we are on a steady turn.

There is no v dot no r dot all that we have got is m this one which is nothing but, this one basically this part m u r is nothing but, this mv square by R capital R with a u will come within the r this capital R, you know this mv square by R you everybody knows that essentially that is m into u into small r which is the same thing you can check that. Now, what we are saying that typically radar is somewhere here below that you know for typical ship you are talking center of gravity is normally slightly above that if you call this to be say draft here, radar is somewhere approximately around the draft middle of that radar, let me call this that H is the point we are saying where the radar force acts resultant rudder force approximately.

And if F h is acting, let us say at a point E and this is my point K here, so what do we have here is simply is something like that F h minus F r equal to mv square by R, that from net force has to balance total F means, total Y force here essentially zero that it comes from the equation also if you look at that because after all F r will be Y delta, delta F h is going to be Y v v plus Y r r.

If essentially if you look at that it becomes that but, I am just looking at that way the moment causing heal this is going to be F h minus, I just follow this here into K G is straight forward. We have done you know that net force is this side into K K to G like you know if you work it out is very simple basically I mean I do not even have to explain that is absolutely straight forward to just take moment about this distance is etcetera. So, ultimately what I am wanting to say something like it will become, see here actually if you look at that it becomes very simple F r minus F h F h minus F r is this side force into G E, G to E distance minus F r into E H F r into E to H is this distance I mean you know this is very simple thing, what the point of saying of all this is that is very simple.

For most ships, for most ships you would expect E and H to be very much close by why? Because you remember that F h is expected to be acting approximately half way through the draft right, an approximate value we are talking if you want do not want approximation you can always do the exact one radar by choice you normally have again almost you know like the draft in fact, if you think you will find the radar area is slightly tapered upwards, so the center of gravity is slightly above the mid way and so will be the pressure because you know more fuller form of the top. So, essentially E H can be approximately this made be it is close to zero, so that my healing moment turns out to be essentially this where G E is you can say G E is G to E and E can be taken as middle of the draft you know, this E can be taken this turn can be taken as T by 2 if T is the draft, so what is happening is very simple you as if you look the other way round.

As if the same point both the force acting so my net force this side becomes obviously or this side become F r minus F h or this side become F h minus F r and you take a moment actually, I told you F h is more than F r, so it is better to take F h minus F r F h is basically Y v v plus Y r r typically that is much more. So, it is and of course, it has to be because remember again this also is obvious because F h minus F r is this, so obviously F h minus F r has to be more.

Because it is turning this side there is a lateral force, so the force has to be coming inward so then what we end up getting is absolutely straight for of course, we end up getting the fact that my healing moment.

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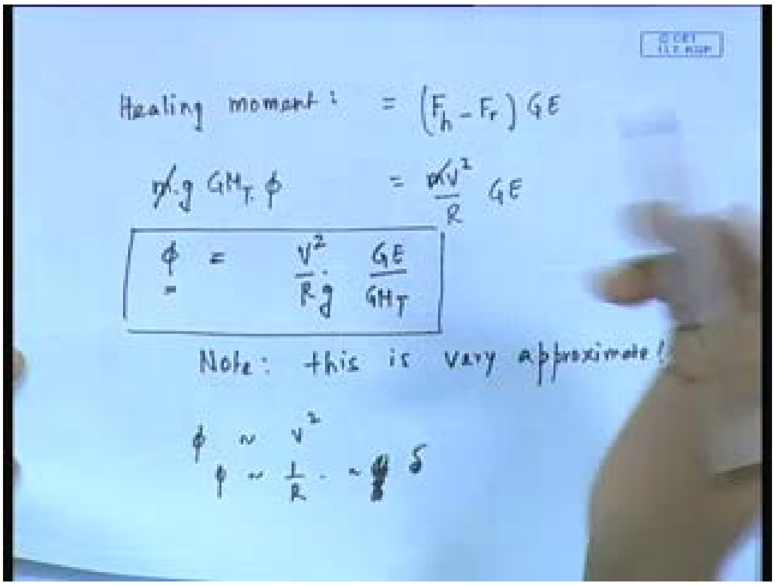

Let me write it in the next slide or you see F h minus F r was mv square by R F h minus F r was mv square by R, so if I put that this will become what is the healing moment? If suppose the ship is healing phi this healing moment is what m into g that is weight into G z g z into 1. G I mean 2 phi, so you have got so from there what do I get m gets cancelled out very simple this is only approximate but, anyhow what do you find again see we are only going to look at this part in this of course, you will find a relation v, v is a here remember v is a forward speed that is what m v square by R when you do v is the forward speed the your force depends on forward speed see now you see here phi.

Phi is in proportion to v square means if you go at higher speed yes you may a have a same radius but, you are going to heal more phi is inversely proportional to 1 by R, you have a tighter turn you heal more. So, if you get large now you have a larger radar obviously if you get larger radar angle, I mean larger radar means tighter R means R is proportionate to delta isn't it or ready no inverse proportional to delta proportion to delta. So, you understand that if I give larger radar angle, I have a tighter turn, I have a larger heal angle outward. If I go faster my radius of turn is same but, my heal angle is larger and so if I am going at a very fast with a large heal angle and suddenly bring back my rudder to zero I actually am looking at a dangerous situation so let us for example.

So, this is straight formula you can use sin you know these are approximate, I presume here sin phi as pi because phi is small if you do not like you can put sin phi. Let us have a for example, a small problem that I it is here let me just work this out see it says from heal during turn that the vessel turns, draft is that's what it says see here this ship is here draft is given as 5 this my keel point K K to G is 6 meter.

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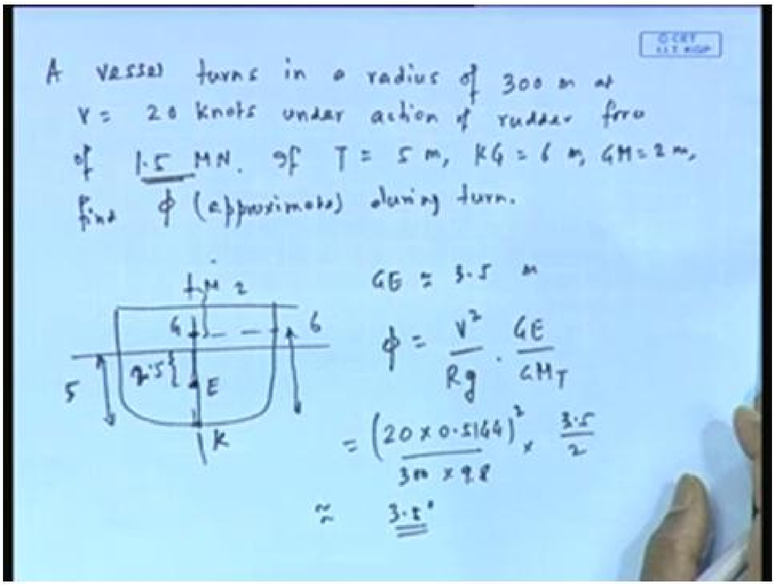

Meta centric height of course, meta centric height to my radar force Y r is given 1.5 mega Newton but, this does not become actually important here now you see my formula, if I go back, I have phi is V square R R g into G E, let me put it down now G this is my E what is my E E is my point of action what do I take G E I will take this to be 2.5 meter approximately after I'm doing.

See this is 5 meter, so exactly so this is 2.5 and 2.5. So, G E become approximately 3.5 meter, so my formula for G M T is of course, is given 2 so of course, phi becomes V square by R g into G E V here is 20 knots, so it is 20 into point. V is 0.5144 by R is 300 meter g is 9.8 say into G, G becomes 3.5 meter. So, if you work it out this would turn out your approximately I am not doing the full work but if you work it out what this interesting points you will see you know, that mass is not coming in picture also in this equation radar force is not coming in picture although had radar force here.

The reason is because radar force and hull force this difference comes in picture which is given by this because of the balance no mv square by R and the aim of course, gets deducted for the roll part, so this is the interesting point that you will find out here. So, here although I get 1.5 mega Newton radar force not necessary, now tell me one thing so like that we can work it out approximately this is not much 3 and a half degree in a normally. You know the heal during turn can be about 5 degree 6 degree it can even 7 degree or so you can see some nice pictures as I said there is a very nice picture of this aircraft carrier US the turning and you can see it is on turning on the outside and turning outside is always more dangerous after all, because it is things will fall outward, you know if you fall over board you will be falling outside the loop not inside the loop now tell me what would be the heal for a submarine.

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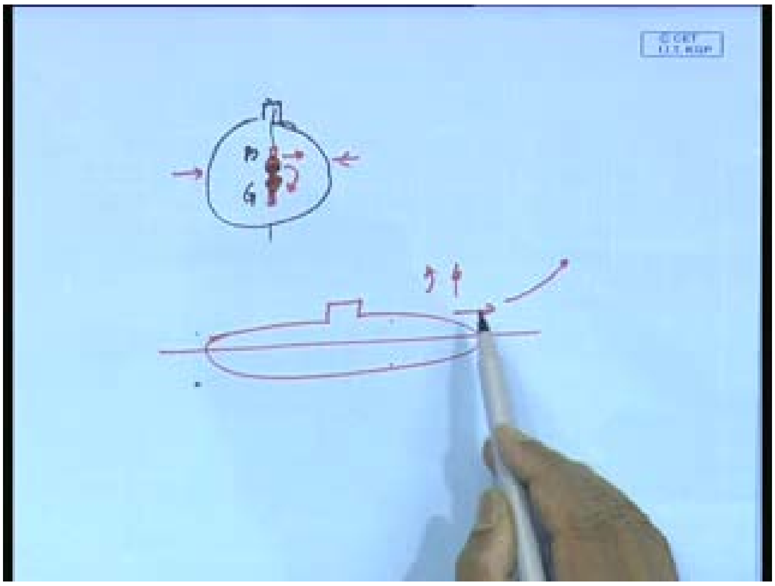

Typically for a submerged body typically, I am not saying a fixed you see here what would happen normally you see here center of buoyancy will be here, center of gravity is going to be below the center of buoyancy for stability purpose. Now, your radar are normally central whichever, so it is somewhere here and radar force is going to be more or less and hull forces going to be somewhere here and here, where as mv square by is going to be at bottom looking compare this to this compare that to this or what we have done in this other this one compare that.

See here my G point was above the point of action of the hull forces but, for a submarine typically because of my stability, my center of buoyancy has to be above center of gravity you agree with that because center of buoyancy is Meta center for submerged bodies, so center of gravity is below that. So, G is typically is below point B and B is of course, the point more or less where the hull and rudder acts.

That means V is equal to omega E point, G is equal to the G point but, here it is opposite G is below, so which side it is suppose to heal it will obviously heal inwards because it will heal inwards now because the direction has changed now you know that this thing about that if you take this thing this moment is going to be like that while inward turn more or less you cannot say for guaranteed. But more or less for a submerged body usually the heal will be inwards although it is very approximate because to find out heal, you have to find out all kind of interplay of the hull forces which is not small number of hull forces will be coming here of course, we just made an approximation in fact, in submarine and all things are much more complicated because as it turns you know, if you make it turn it also goes down or goes up it does not stay in a same plane.

Because as it turns I mean just on the slide want to tell you how the hull forces come, as it turns in horizontal plane it necessarily produces an upward or downward vertical force pitch and all, so the therefore what would happen if it is upward force it will pitch up and, so it will spiral up or it will spiral down mostly by design, you design it such that it, spirals up mostly in fact submarine submerged bodies things are much more complicated, even if you want to go on a straight line it will actually surface because the top and bottom are not symmetric typically you know like. I am just on the digressing little bit but, if you see that that top part of the flow are same, so as you go this side there is a net force and net moment coming and it try to go up therefore, why this is important therefore, you cannot study the horizontal turning or vertical without the coupling for submerged bodies you cannot say in isolation I will make it turn because it turns it spirals down because horizontal motion necessarily produces vertical force.

Vertical may not produce horizontal because of ports starboard symmetry but, horizontal does produce always vertical but, what I am saying in a straight line motion also unlike in a ship, because there is no buoyancy equal to weight is a hydrodynamic force become much more critical because you know in a ship, in this plane you push it down buoyancy will push it up buoyancy force is so large.

Push it down, then push it up get pushed up but, in submarine you push it and come down. So, what it will actually cause it to go up only hydrodynamic force, so hydrodynamic roll of hydrodynamic becomes even more critical vertical plane for submerged bodies you know slight forces can cause it drift, I mean you can see that you know I was remembering your this thing that slight forces there is no propeller body keeps drifting so we have said this. Now, I am just going to spend some little time on trying to tell about some of this what I should say IMO requirements, IMO requirements on this stability issues before if you have time we can go to some vertical plane motion. See we have just more or less understood turning behavior heal during turn etcetera, etcetera. We now know why we should not certainly stop the radar while turning.

We also know the radius of turn really do not depend on speed as much but, the heal angle depends, forces depend radius of turn does not depend because the it is a interplay of force by force.

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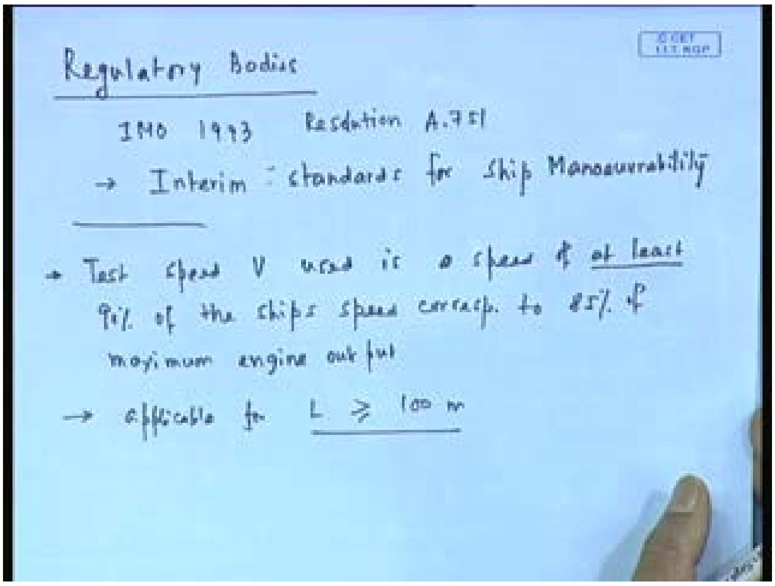

So, it becomes neutralized there additional course etcetera, etcetera. Having said all that you know that regulatory bodies all regulatory, bodies they have to stipulate some requirement of what do you call a good manoeuvring or acceptable manoeuvring criteria like your stability.

We have got IMO requirements stability criteria, so there are similarly criteria which is I can tell you IMO 1993 I want to just the resolution A 75 on what is called interim standard for ship maneuverability some of the points saline points, I want to tell some of not all because then you understand that you have designed a ship, so you understand what characteristic or what you know like properties as far as manoeuvring is concerned the ship must satisfy.

Nobody actually stipulates usually that you have to achieve that but, there is an upper bound like stability you know and most of these rules are connected to safety whether you are able to turn or you are not able to turn the rules do not say you should have safe manoeuvring characteristics. So, I want to just mention a few of them this application of this rules only a few points, so this there is some rules given it applies essentially to zig zag manoeuvre and turning manoeuvre and also stopping trial but I will not tell. In other words basically you have to make sure that your ship is within those limits why I am saying, because you will find out that the limit in zig zag specially it is not that you have to be very highly control manoeuvre the ship basically the limit is on both sides, so here some of this thing is like this the test speed the important one only I am writing corresponding to I thought this is very important point.

One point see this standard will be applied at a speed which will be minimum 90 percent at minimum corresponding to 80 percent of the engine power, which means you have stipulated a speed to do the test at that speed, not at the very low speed or high speed or something like that then they apply for this thing will apply for although, it is says this is the rules have been made for more than 100 meter long ships you know now a days many many people are applying them in for smaller vessels also because otherwise there is no criteria really and there are many other thing deep under.

I just want to tell you about the actual criteria with respect to the manoeuvring rather than many see any rolls will have many stipulation was example it will say the standard of manoeuvre should be performed without use of manoeuvring aid a condition of standard apply in deep understated water calm environment full load even keel like that so many are there.

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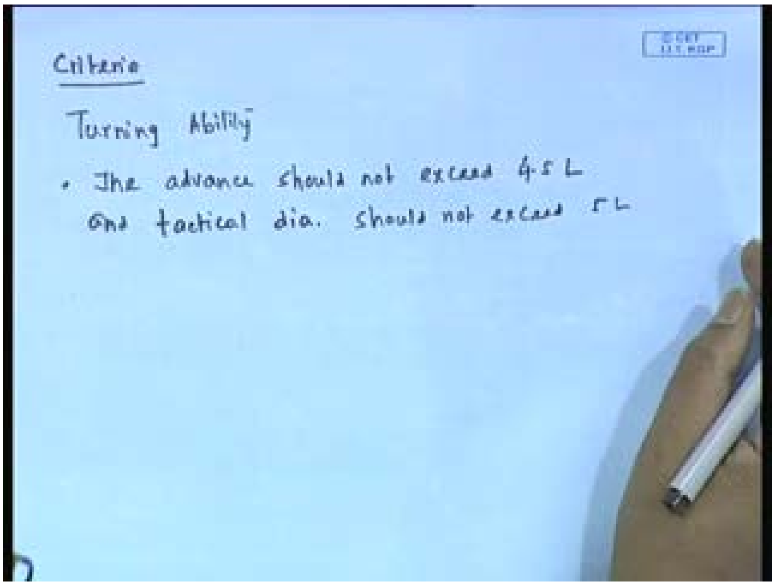

But let me just look at this criteria, the criteria are this is the most important one now turning see turning ability now you will see what, when you are doing a design this becomes important you have to make sure that your design confirms to this standards, see here the advance, here advance means the distance it move forward when it has changed 90 degree heading which is also you know like specified earlier.

The advanced the word advance in the rule they also said what is advanced etcetera, advance see this is one should not exceed 5 L see here, I want to tell you this if you look back in my very, you know like one of this earlier this diagram of advance and transfer I will just bring back this, I will just take the advantage of see here transfer is this or tactical diameter is this advance is this turning circle is this.

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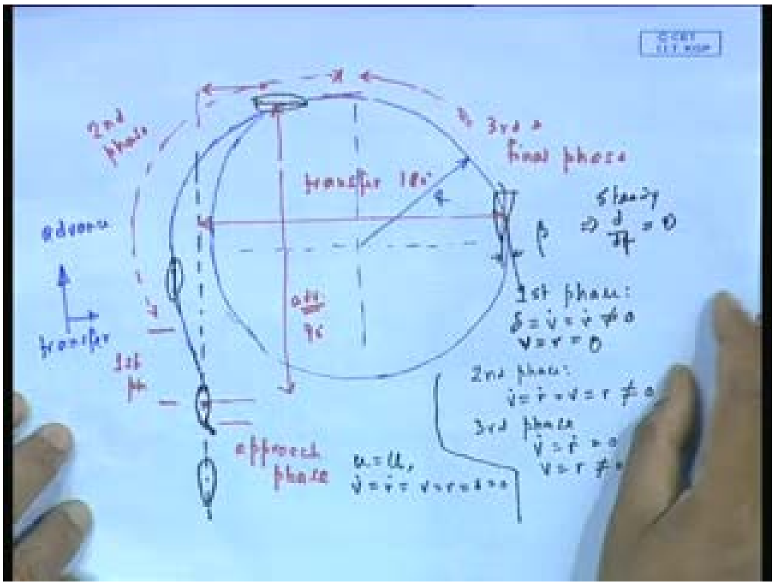

Now, turning circle is not entering in picture here, which is what I have given another diagram that here also see this rule applies only to I am just drawing an exaggerated diagram.

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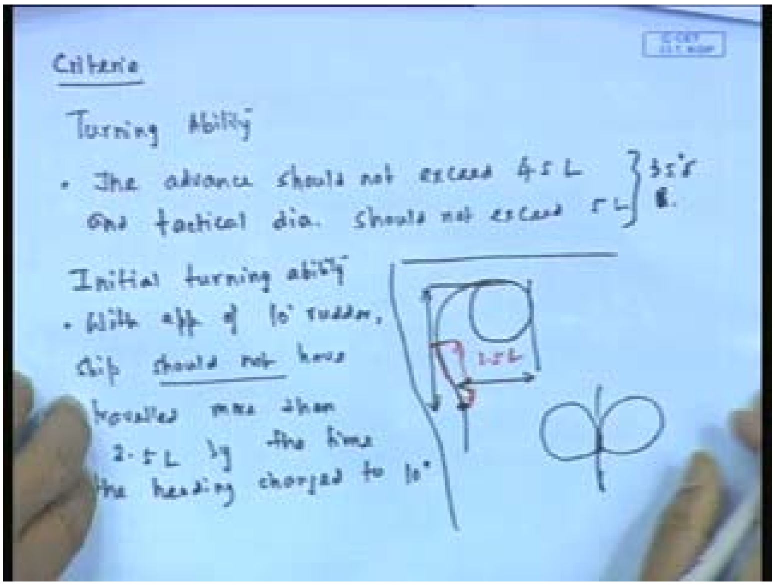

It is applying only to advance and transfer, it is not applied to r obviously the moment that is, so you know this rules are basically safety rules because it wants to make sure it does not go beyond some length in the x direction beyond some width in the y direction whatever the turning is. So, these are basically safety rules you can easily see that you know from this stipulation here and when you therefore, really the rule does not bother whether you are able to turn or not it simply says if you want to turn make sure you do not hit the other side, it is so much of water front in front and make sure you do not hit the you know the right hand side that is what it says then the this is one rule.

Then there is a, then there is another one called initial turning ability the next one let me write it here only by the way I mentioned that a little later here this also this turning ability I should have mentioned also here that this turning ability has to be done at 35 degree of radar or at the maximum radar for which the ship is designed there's also is specified they at a standard. I did not mention that, this is this is very important at this here turning circle is to be manoeuvred with 35 degree of radar or maximum radar angle permissible at test pit following a steady approach with 0 your 8, so this is to be at a 35 degree of radar let me also tell you delta this test is also has to be done port and starboard, now I will also tell you this.

Tell me for a typical ship do you really expect the port turn and the star board exactly symmetric why not? If it is not symmetric why not? I before, I write that let me you know continue on that why it is that port side turn and starboard side turn the test says why I am saying that the test says that I did not specify this only telling only one criteria but, this test has to be done at 35 degree radar or at the maximum radar permissible as you design most ships are designed 35 degree radar. But for both port and starboard size my question is why both port and starboard size then? Give me a reason why what could be a possible cause why port turn and star board turn may asymmetric? Slightly even if it slightly no see remember, the see remember that the forces depend on the hull shape, hull shape is symmetric purely see the answer is in propeller mostly remember the radar is behind a propeller.

And the propeller is behind a propeller and the propeller is a single screw propeller, propeller has a symmetry it is moving in one direction, so the flow has slight asymmetry in one side remember that the propellers moves in one side, if it is single propeller, if it is twin propeller it will be much less theoretically not will be zero, but single propeller you will obviously if the propeller is this side there is bias for the flow on one side. So, the radar in this side and radar in that side it may not perform in a same way that is why they say that you must do the test on both sides that we did not do this kind of modeling and this kind of modeling will come in when we discussed later on full non-linear simulation with all kind of hydrodynamic forces.

Now, let me write the other two quickly this criteria it says the with application of see this read this initial turning ability with application of 10 degree radar, the ship should not have travelled more than 2.5 ship length means the with you have given radar somewhere here it should 10 degree radar only it should not have gone beyond this length 2.5. By the time its heading has changed to 10 degree what it means supposing it has gone beyond what it means? You know it basically means that it is responding very slowly to radar see after all supposing what does again say it stipulates the condition on how fast it respond to radar because imagine it is going at a full speed you give a radar, it is responding so slowly that it has actually gone much further by the time the heading has changed 10 degree not accepted.

It says you must have the heading change 10 degree before you have reached 2.5 l along the x direction; see the ship should not have travelled more than 2 and 5 length by the time the heading changed to 10 degree. So, it basically tell initial responsiveness of the hull to the radar initially hull must respond, because otherwise it shows it is very sluggish, it is responding much let may be it will achieve a turn that would imply actually something like this, see this is actually the picture, I will show you the difference is that one ship will be turning like that and another ship may be going this is not accepted.

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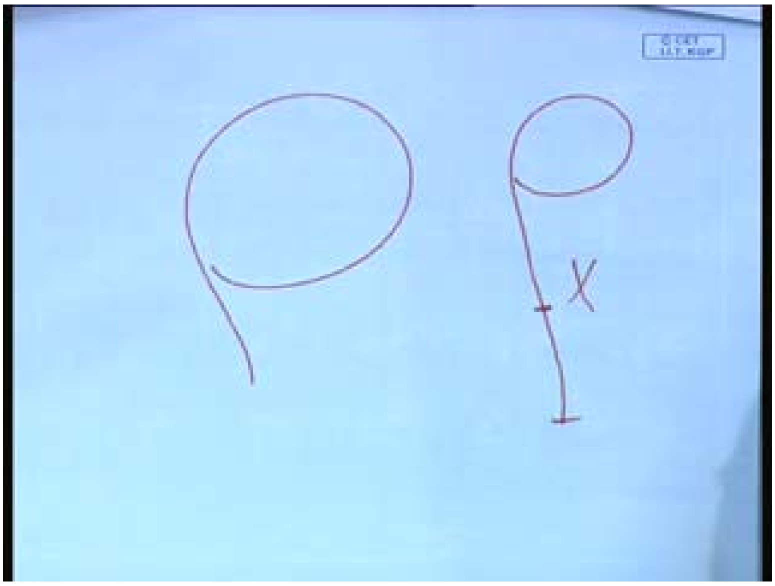

Because this one means you are actually coming much higher, but yet you do not have actually the turning rate. So, that is this condition stipulates this basically that means it puts a boundary on how initially it will respond.

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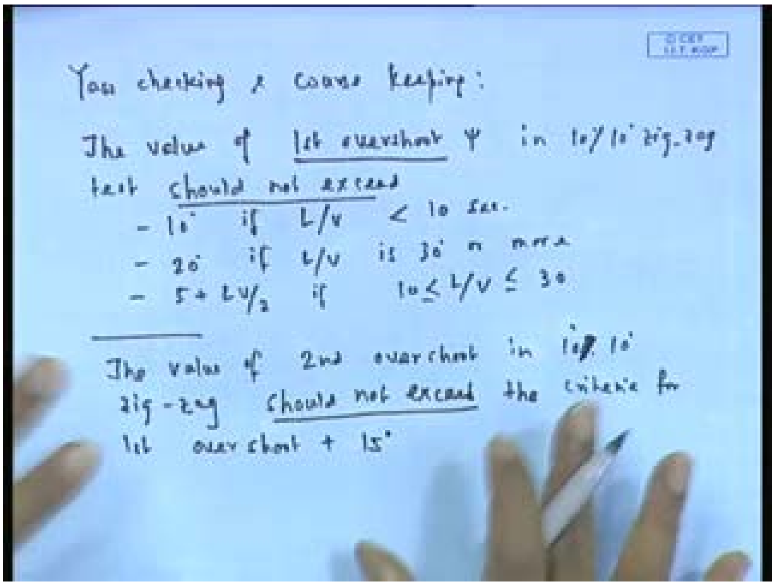

Let me quickly go to this the zig zag manoeuvre, the zig zag manoeuvre or yaw check or course keeping it says see the should not exceed see here.

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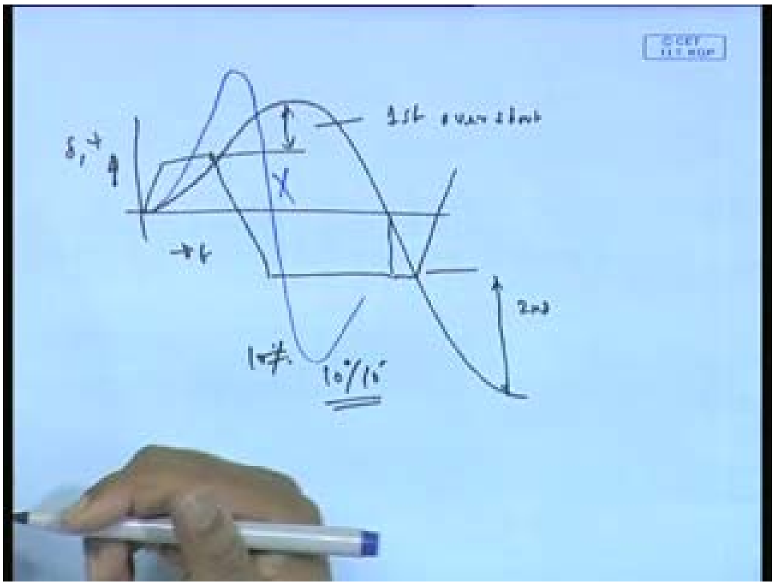

I will this is again interesting, I will just let me draw this diagram this see this overshoots here say this is like that, so this is my first overshoot this what it says you know why I am telling in a 10, 10 manoeuvre 10, 10 degree zig zag. It says it puts a limit based on of course; L by V that means there is a dependence on, there is a dependence on length and speed by which it says that I must have a limitation of my first overshoot.

It cannot be more than some value see and the second also there is a limitation that is this plus 50, that means the rule has put a limitation on the overshoot angle it cannot exceed the overshoot angle more again for safety that you have to make sure that your ship now you see why I am saying this I told yesterday's class that if suppose the ship is highly manoeuvrable that it normally reaches faster but, overshoots much more not accepted. So, you cannot have a ship which goes overshooting like that overshooting like that no see a ship which is highly manoeuvrable will try to do that very quickly turn but, no you cannot have that beyond certain limit that is what is stipulation, exactly a same stipulation I will just have to write very quickly 20, 20 manoeuvre in for 20 because where 20 zig zag it says.

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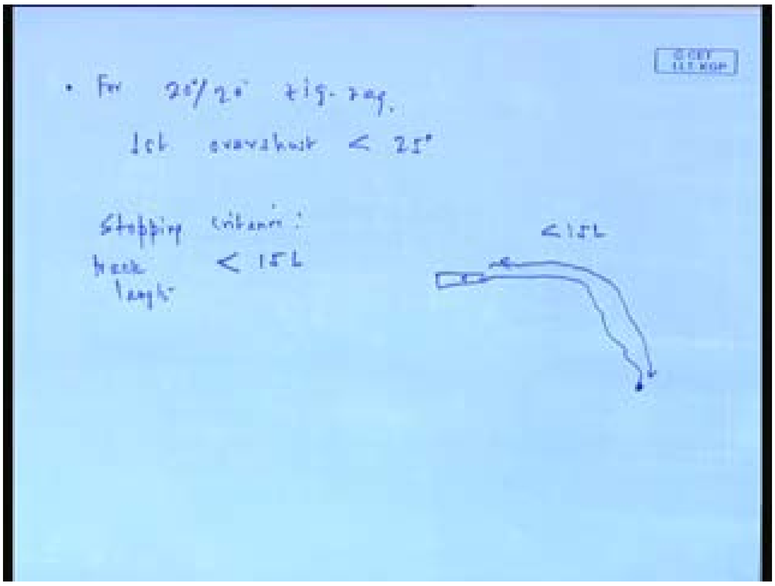

The first overshoot should be less than 25 degree it says that in 20, 20 manoeuvre first overshoot should be less than 25 degree, that is the other criteria there is a there final one I will just end up stopping criteria it says, which we have not talk the length of stoppage should be less than 15 ship length track.

See suppose you are stopping the engine the L basically goes like that and ultimately stop here because it will never be straight line because you put a radar and all, so this distance less than 15 L it says. So, what I am saying that this is the criteria never mind stopping criteria but, zig zag manoeuvre you have seen that basically it is stipulating a limit on the top, so I will end it at this point, but I want to just mention saying therefore, what happens for ship these trials is that. You conduct the trials you know the assessment but, from rule point of view you have to make sure that you are satisfying this criteria; if you do not satisfy the criteria they will not approve it. So, I am you consider criteria's are all both ways you cannot really have two manoeuvarable ship, because then it this criteria must be exceeding etcetera, etcetera. So, with that, I am ending here; we will see what we do next class.