Marine Construction and Welding
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Module No. # 01
Lecture No. # 22
Plate and Section Forming – I

In the sequence of activities, we will take up plate and section forming, because we talked in brief about the plate cutting. So, once the plates are cut to the required sizes, there maybe - there will be requirement to shape it; that means, bent it to the required so that it confirms to the hull form.

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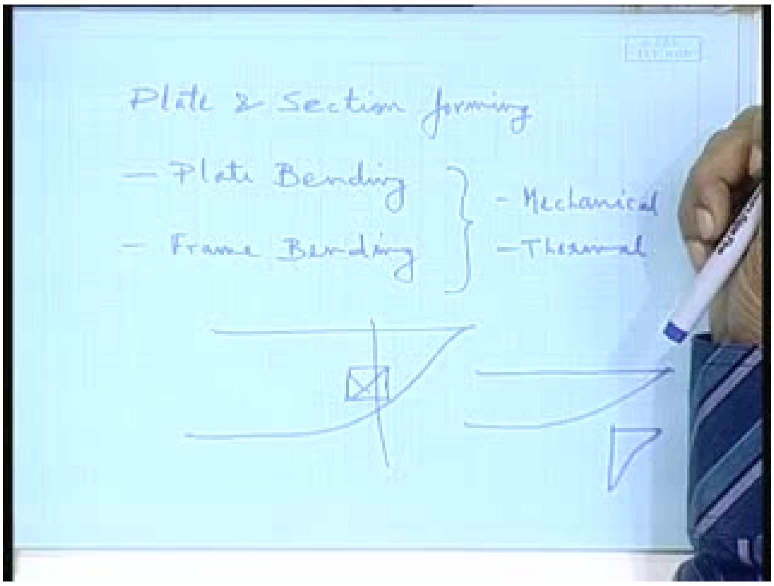

Well, depending on - suppose you are making - cutting a plate for fabricating a bulkhead - a flat plate bulkhead, then naturally question of shaping or forming does not arise. But, if the plate forms part of the bow, a plate here, for example this particular plate will have a curvature in this direction, means in the horizontal plane, also we will have the curvature in the vertical direction; that means this is my lines plan in the vertical direction and also it will have some curvature. So, those ways plates need to be bent whereever there is a curved form is coming (Refer Slide Time: 01:15).

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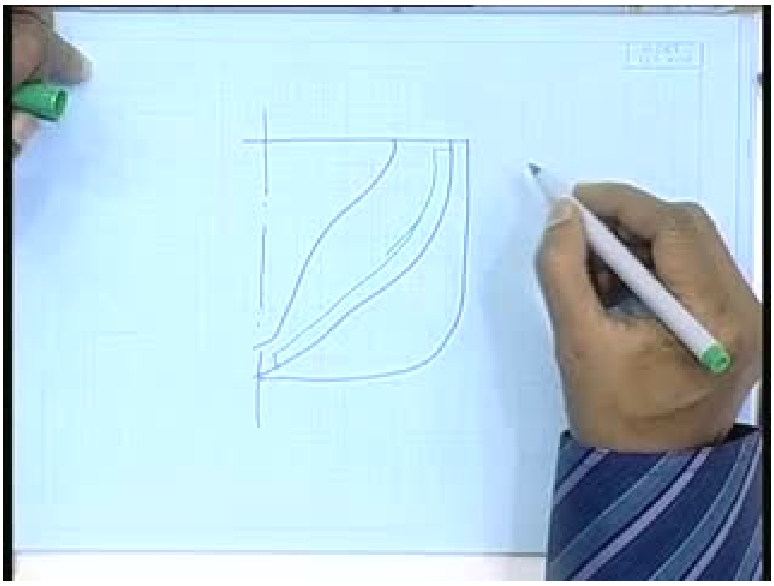

Similarly, once you have the plate here, you have to bend at the same time - the sections or the frames need to be bent. Because, if we look into the frame plan, I mean, you may have done body plan, now, if the same body plan, if we now draw for each frame - a different frames, then you may have something like this. If this side shell is stiffened with a sectional frame, so the frame also needs to sort of follow this curve, isn't it; that means the frame has to be bent. Here, the plates well - the shell plate and these frames can be angle section or t or bulb sections, so they need to be bent.

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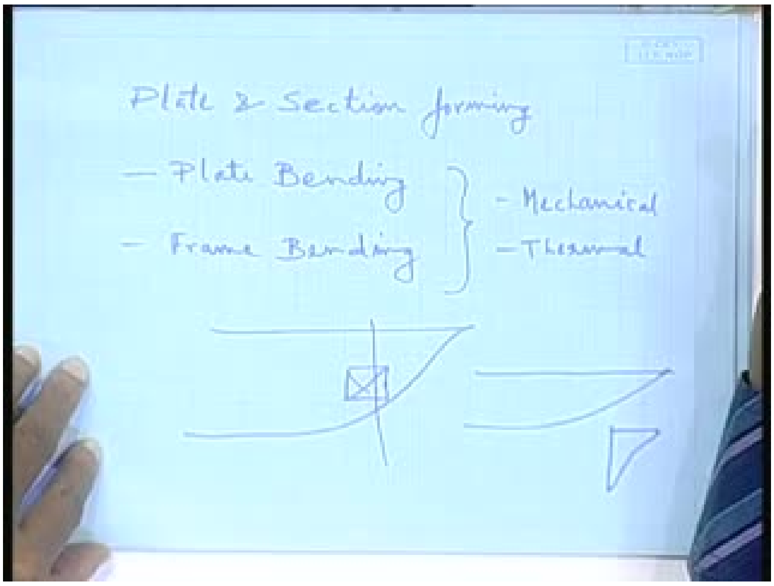

As we see in this sequence of activities, right from after the plates have been cut, they may go straight forward, so called fabrication of subassemblies, where there is no bending required. For example, the plate floor, it straight away goes for subassembly, means the floor plate with struts welded to it or the bulkhead - it goes for the bulkhead panels, I mean all individual plates are welded, then the frames are welded stiffeners, but if it is the strong part of the ship or what do you call the bilge plate or the forward part, you have to bend them. So, we have so called plate bending as well as, frame bending is needed.

How they are done? They can be either by some mechanical means or by some thermal means. Means for bending, you need to apply a force such that it develops a stress level beyond the elastic limit of the material, thereby you assume a permanent deformation and that is what is bending. So that force can be generated mechanically or thermally, by thermal loading also I can generate the similar type of force or I may say similar type of bending movement such that I achieve the bend.

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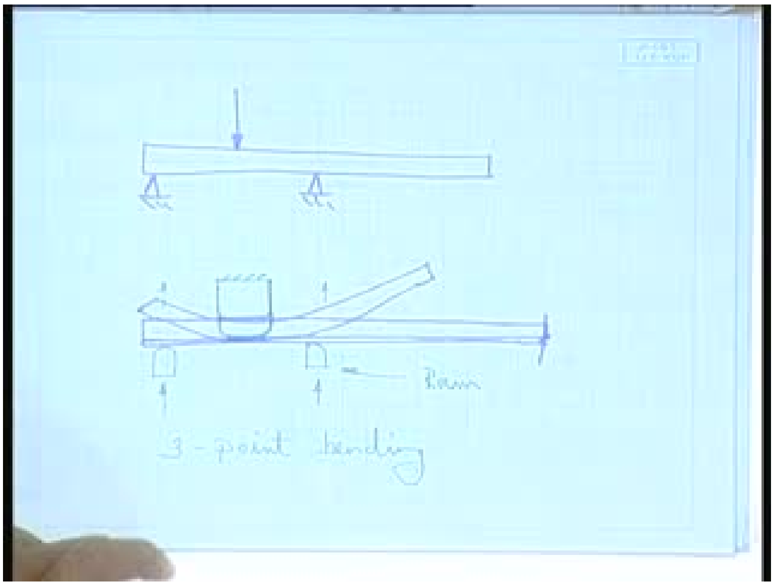

Let us take the case of frame bending, which is simpler, so frame bending means what? Basically frame, it can be thought of as a beam, if I have some such configuration and apply a force, so it bends. That means two supports; one support I am applying a force, so the same thing from this simple configuration. I can think of a machine where in which can be a schematically represented like this (Refer Slide Time: 05:03).

Imagine this green one's I am drawing, they are sort of moveable RAMs, say the central one. There is a central support, this is fixed, these two small once, they can move; they can move means you can apply a force. It can move in this direction, also it can move in that direction and it is not correctly drawn, let us draw the what do you call this is my flange, because whenever I am using a frame, it will be essentially an angle section or can be t section or can be bulb section. You have the flange, this RAM actually is resting against the flange; the center one this is extended, not here; this is extended.

Suppose, you apply this left and right RAMs, they are referred to as moveable RAM. So, you apply the force, what happens? It will bent, simply the frame will bent in this shape; it will bend in this direction. So, what one will have to do is, you would apply the force and it bends. How much you should bend it? That is what next will come, but this simple method is called three point bending.

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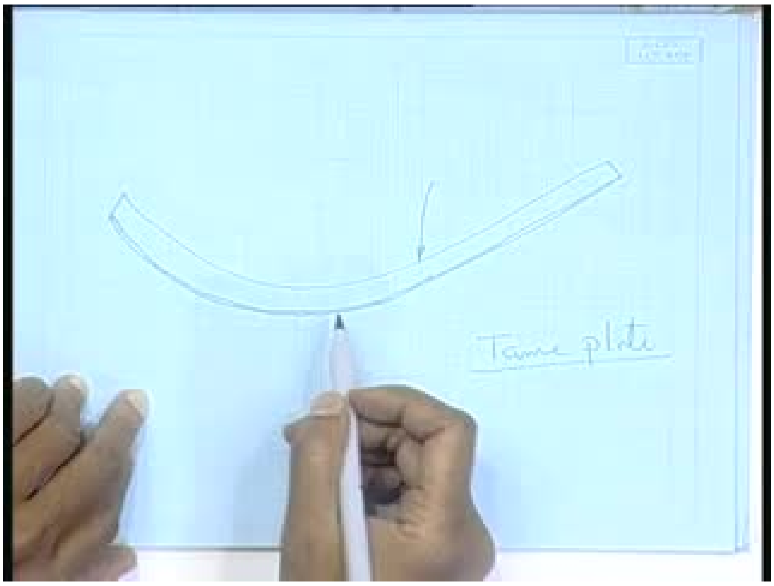

This is the simplest way you can do; that means, there is no heat applied in the cold condition, you just put the frame on this fixed RAM - right on the central RAM which is fixed. Clamp it properly - the machine that will be clamping, then the side RAMs it pushes it. It is basically hydraulically operated machine, so it bends. Now, suppose you need a bend shape - frame is needed of this particular shape and the whole length could be say 8 meters, 6 meter, 10 meter can be - I mean maximum could be probably 10 meter also the length of the stiffener.

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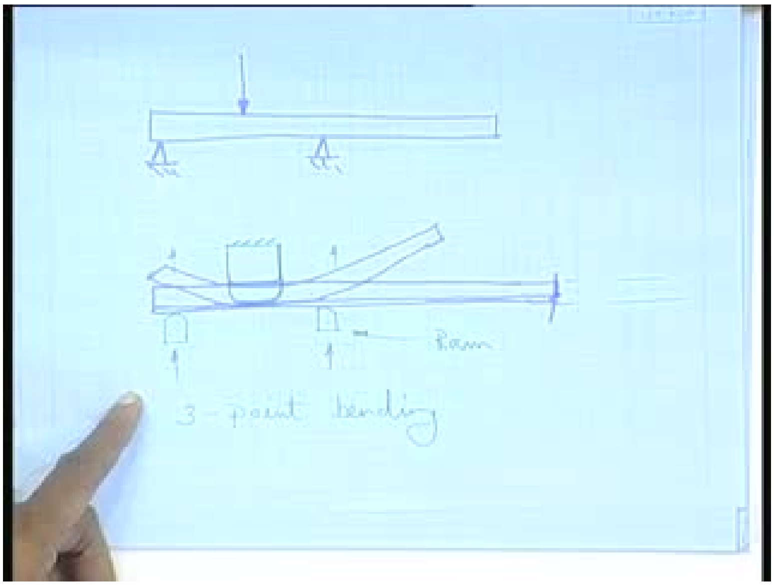

Here, the spacing between the RAMs could be 3 meter, could be 2 meter depending on machine capacity, but my frame length is much longer. Here, I have drawn with a broken line that means it is still there much longer. So what happens? The sequence operation is, you put the frame, fit to the machine, give a bending, release the load, fit the beam, again give a bending, release it, fit the beam and bend it; that means you will keep on fitting it and bending it. So that gradually you approach the shape, whether you were getting the shape or not, because here, we have the way I have drawn. I have the flange in this side, so that means my final edge which should confirm to the hull form or the hull line, is this particular edge, isn’t it.

That edge will be - this particular edge will be connected to the shell plate, I am just arbitrarily thinking of some shape. That means I should check whether this particular edge is confirming to the shape or not, so for checking that again a manual operation something called tame plate is made. Tame plate is nothing but – because, once the hull form is designed, you have the frame plans that means off set table for the frame sections. So, based on that you make full scale tame plates; full scale tame plates means, either of aluminum bar that means that you bend to that particular shape manually. Or from plywood you cut it in that shape, so that becomes a tame plate, means a standard; that shape is made of that.

So, once this is being bent stage by stage that means little bit you bend, fit the frame, further you bend, so in between process, you will put the tame plate inside in this machine. You will put the plate on top of it, the tame plate to check whether it is taking the shape or not. It is just a pure manual tedious process, little bit you bend, put the tame plate and check, and then you will know that how much to be fed in, how much to be further pushed, bent. So, it is a basically skill dependent, means you and me would not be able to do it, will be able to do but that will take too much of time. A skilled operator will have an idea that how to go about for a given shape, you will get it very fast, very fast means also will take few hours.

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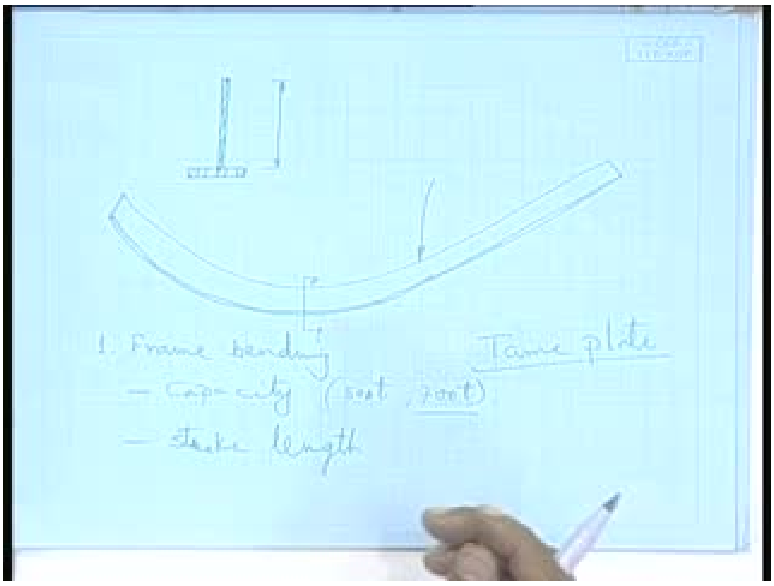

So, these are simple bending operations, so what we need here? What we need here is the parameter; that means, a frame bending machine primary thing is, what you need is so called frame bending machine.

What is that machine made of? What would be its parameters, its capacity? That means capacity in terms of how much of force it can apply - that RAMs how much of force it can apply? They are generally of the order of - there are frame bending machines, can be of the order of 500 tons or 700 tons like that; that means that side RAMs can apply 700 tons of force, it is a huge force.

Why that is needed? Because, you may need to bend heavy sections, the sections of dimensions 600 millimeter say the wave height, thickness of 20 millimeter, heavy sections may need to be bent. So that means, essentially how much capacity the machines should have that will depend on - because this machines you will not have many of them, you have only one, probably frame bending machine.

So, one should know what is the product range you are going to produce, the shipyard is going to handle. So, depending on that product range what range of stiffness you are going to bend in that. So, once you know that you know the section dimensions of the stiffener, section modulus of the stiffener. Once you know the section modulus of the stiffener, suppose your stiffener say big girders, have to be bent like this - big t girders, where probably whatever be the heavy dimensions.

So, you know the section modulus of this, you know what kind of steel will be used. So, depending on that you can find out how much force is needed to exceed the elastic limit across the entire section of the material. Because, when you bend it fully, then the whole section goes under plastic deformation. That means elastic limit has to be exceeded, so by that one can calculate how much would be the power needed of the machine. So that is a question of when you decide about which kind of machine is to be procure. So, once you have the machine, then well you know up to that much you can do it in this, beyond that well some other method has to be followed. So that is number 1; that is the capacity, the power, how much? It can give - another is the stroke length.

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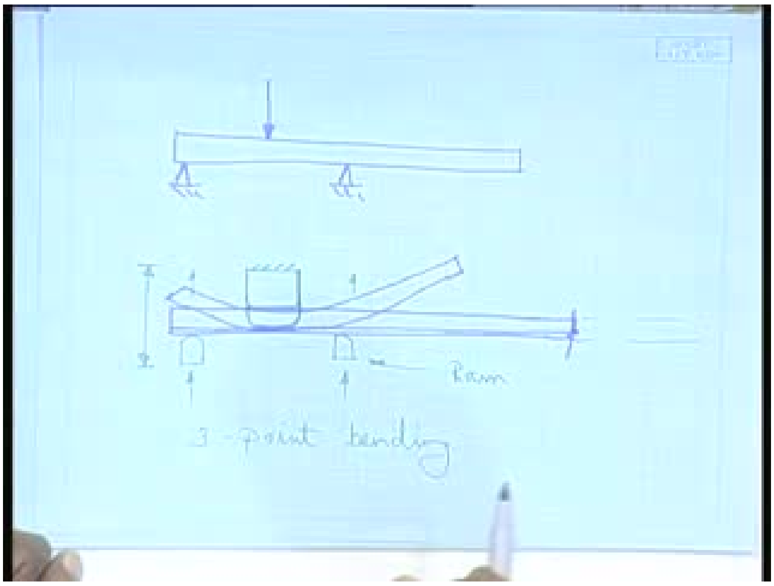

Stroke length is that determines this side RAMs, how much it can move? To what extent it can move? Because, when it is bending, it will go a certain extent, how much? That again limits the curvature. What radius of curvature can be achieved? Anyway, so these are basically two things; the capacity and the stroke length. So that is what in very simple term a frame bending machine.

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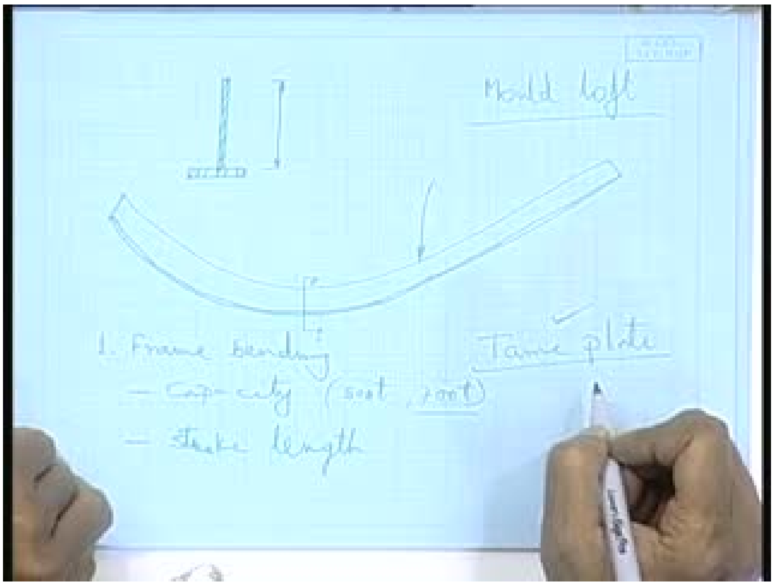

Now, as I said, to check this edge whether we are getting the correct edge or not, we use tame plates. Tame plates means again that is an additional job; that means some kind of frame bending already you are doing, but that you are doing with a very softer material.

So, what happens exactly is there is something called mould loft. In the shipyard, mould loft is where you do the expansion of the drawing. Expansion means, shell expansion - suppose you have to do shell expansion, is nothing but your shell is a three dimensional plate that has to be expanded to a two dimension that is what it is called shell expansion.

In other words, these days there is in mould loft, we do not do any more shell expansion, because that is already done with the help of computer; that means, it is already done by some so called numerical means; it has become easy, but still a mould loft space that in mould loft what it used to be done, is you draw the entire vessel in full scale. That means you see huge drawing hall, on the floor you draw it in the full scale, because you need the full scale sizes. That developed plate has to be in full scale, then only you know what size and what shape of the plate is needed, which one given the proper bending, will fit to the hull form. So, they basically draw the frame lines, put this aluminum thing and mild hammering, you just make it confirm to that shape or paint it over a plywood and cut it, so that is how the tame plates are made. That is why it is a very crude and simple method, but there are not many variations available, we will talk about the variations. So, this is how this is done. So, in this process we see, as far as the productivity is concerned is very poor, because firstly this tame plates are to be made that is an additional job.

You have to preserve the tame plate, because suppose you have five ships in series, in your building; that means, such frame five numbers will be needed over a span of probably ten years. If every ship takes two years on an average, then ten years, so first - for the first ship, the tame plate you have made you have to preserve it till the tenth year.

Well, these are not small thing that you keep it nicely in the cupboard, it will be big ones, so keeping it storing, it is difficult and then all the likelihood that the five times you will be making the tame plate. Means those are nonproductive work, but without that you cannot do.

So, these are the advantage of this machine, that means it is very simple to operate, it needs a skilled hand, but disadvantage is you know to have a take help of such tame plates, productivity is low, slowly it will progress, you over bend it, then you can straighten it by reverse action, by mistake you over bend it, by reverse action you can straighten it, so that is how the frame bending is done.

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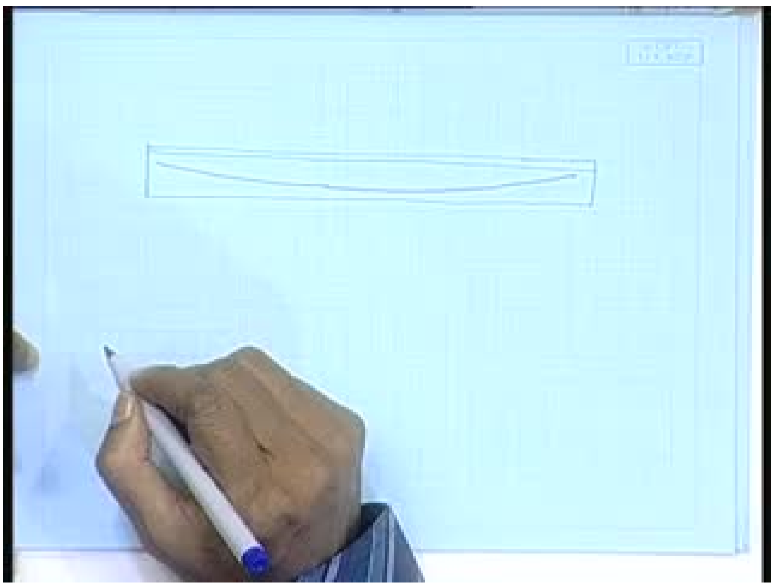

Now, we can see one of the wastage is the tame plate – making the tame plate. So what could be another method of doing it? It is something like this. Originally you have the frame, I mean the beam which you are bending is a straight beam, isn't it or the stiffener which will be bent to get that frame shape, will be a straight one.

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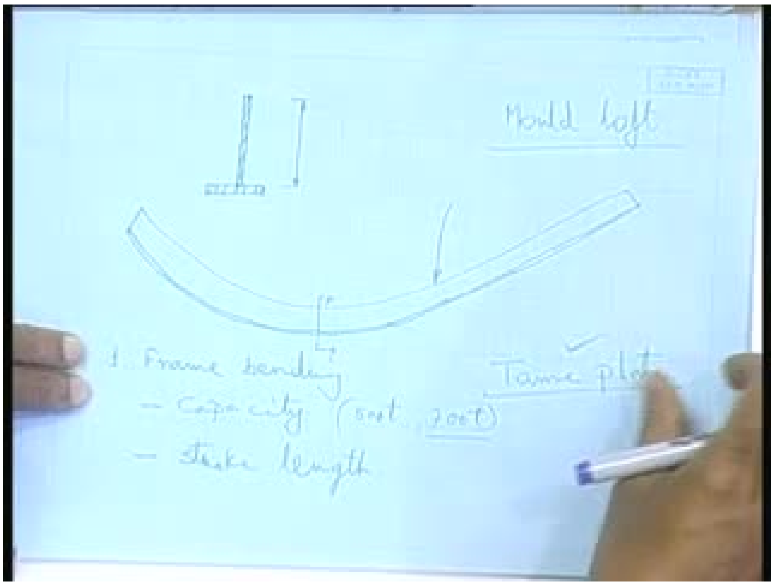

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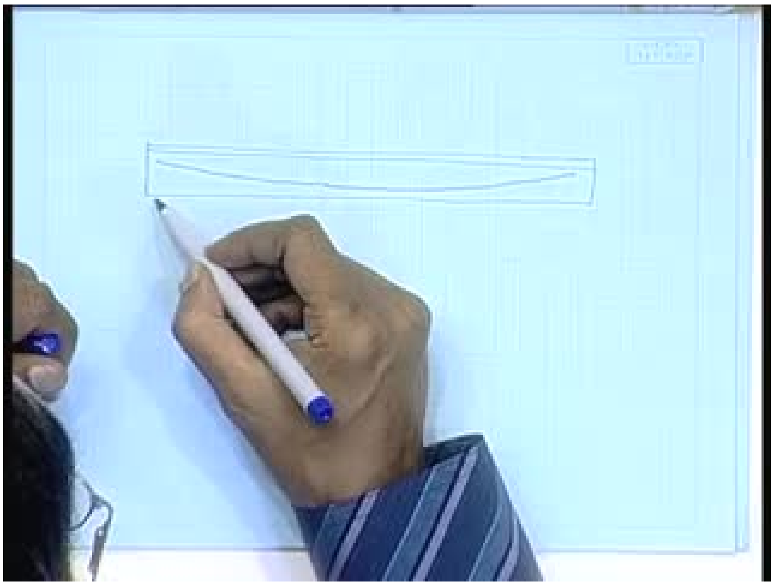

So, you draw this edge that shape; what shape it is suppose to take that is drawn over the web. That means from the frame plan, suppose this edge from the frame plan, I know the shape of this curve that curve is drawn on the wave of the frame which is to be bent.

Now after I bend it, what will happen that will become straight, so that is how - what is being done before we put the frame over the machine, the frame bending machine.

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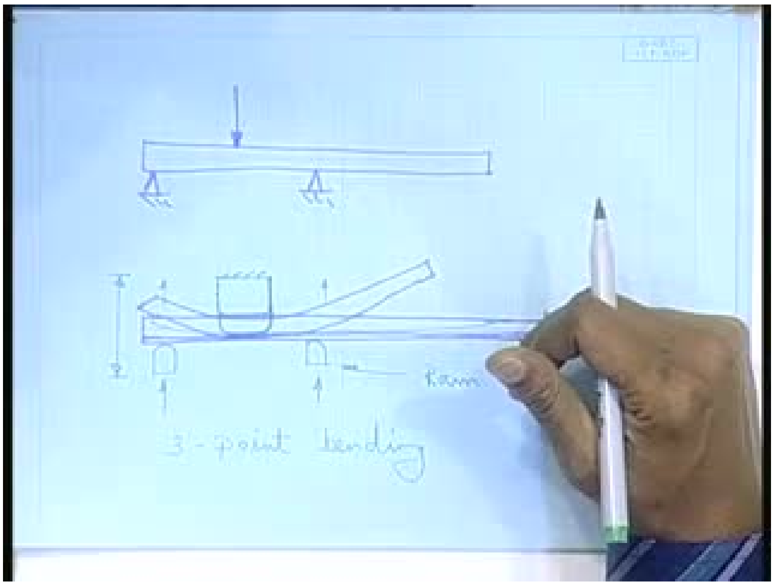

I have the curve drawn already, I have the curve drawn on the web, then go on bending it and go on observing that line, whether it is becoming gradually straight, because gradually I am feeding it and bending it. So gradually I am getting the bend shape - outer plate, in the process, gradually that curved line - oppositely curved is becoming straight.

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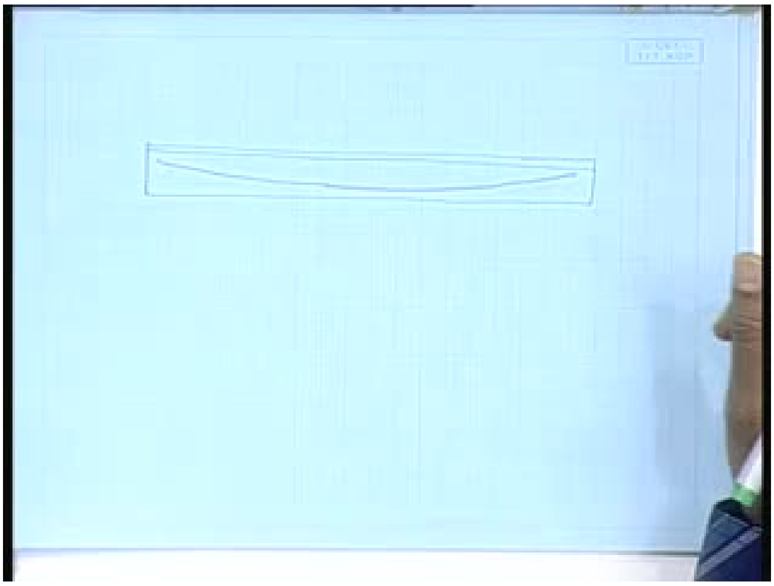

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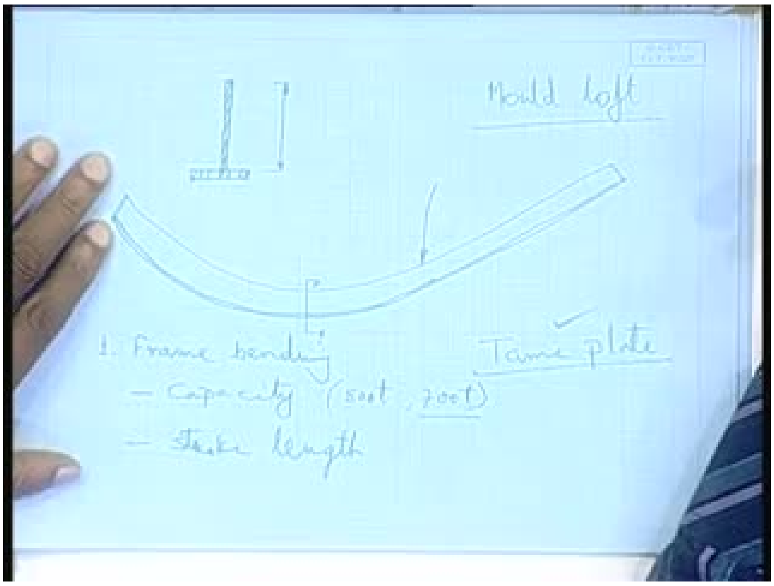

So if that can be done properly, then you do away with the tame plate business, one great unproductive work is reduced (( )). It has limitations, but many can be done, because one of the advantage in ship building is the curves are generally of very gentle curve, very high radius of curvature, not very sharp curves - it do not have.

So that this shape what I have drawn, if it has this much of only web depth, it cannot draw the curve, definitely not. So, where it is feasible, where the curve is very gentle and you have sufficient web depth where that curve can fit - physically fit, there this method can be used.

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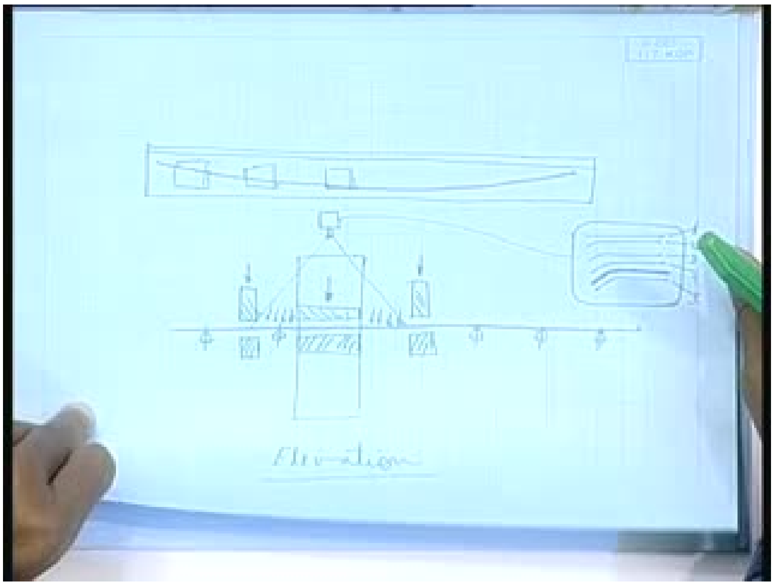

Then you have some advantage of cutting down on the nonproductive work. Obviously, this is very easily said, but in real practice it becomes difficult that first how do you draw it. You can draw - you have the data is some - you have to plot it and draw it physically. Draw with what? If you draw with choke, it will get erased. So, again quite a lot of work involvement is there; that means I am not totally doing away with the nonproductive work with tame plate. My point of saying this is that one can talk about something, one can design something sitting on a drawing board, but actually you will have to see how you are implementing it.

Whether that is adding some value or not, because this is very nicely said, but in real practices again it is not so easy. To make it effective, then what you will have to use? Some kind of ink which will not get erased in the process, because here gradually feeding the plate in the machine, the machine will clamp the web. When the bending operation will be done, the wave will be clamped.

Clamped means there will be supports on both, I mean both top and bottom of the web and it will be bent. So, there will be rubbing taking place, so this line may get erased, so those are problem, but still this could be one of the way. What could be the next better option for this?

Next better option would be something like this. Think of a situation that you have the - say your frame is here, here what I have drawn schematically is the frontal elevation of the machine, but in an absolute schematic form this is my elevation - very simple elevation; that means, I am showing the central block, this is fixed.

The top one, it comes down vertically and holds the frame in position. These are my side blocks, side RAMs, this also comes down and holds the plate clamp set. They can move in this direction, because this is the front elevation. Think of a situation that if I could have installed some kind of a camera, which has an angle of vision of this much. So what is being done is that when you are bending it, this camera captures the edge - definition of the edge that is processed.

This data comes to a so called COT or to a computer monitor, this green line I have drawn that is it has been fed little bit and little bending has been done. Finally, I will have to achieve a bend shape of this much, this is the one which is the as per the frame plan and this is after the first stroke - first stroke of bending. When the stroke was not there it was straight, initially with first stroke it has come like this, with the second stroke it has come like this, with the third stroke like this.

Forth stroke, let us assume, it has come almost same as this. What I am saying is, this is my initial, this is the little - I have fit the thing little bending, I have given - this is further I have bent, forth one, fifth one. So, by the fifth operation, it is matching with that. So, I can have a mechanism of putting this green curves move up and down. This is continuously displayed at one end at the bottom; that is the shape needed, this green one's are being generated from the camera picture, so the fellow is sitting in front of a council, is operating the RAMs. Because, you need not stand here, you can sit in a comfortable room, from where you where can just see the machine and you operate it looking at the computer terminal.

See every stroke how it is coming, if necessary you bring that green curve down and super impose on this curve, see whether it is matching or there is a deviation. Depending on the deviation you go on operating this that could be one way by which you totally do away with the problem of tame plate. Do away with the drawing of it on the web plate and it becomes somewhat a semiautomatic process.

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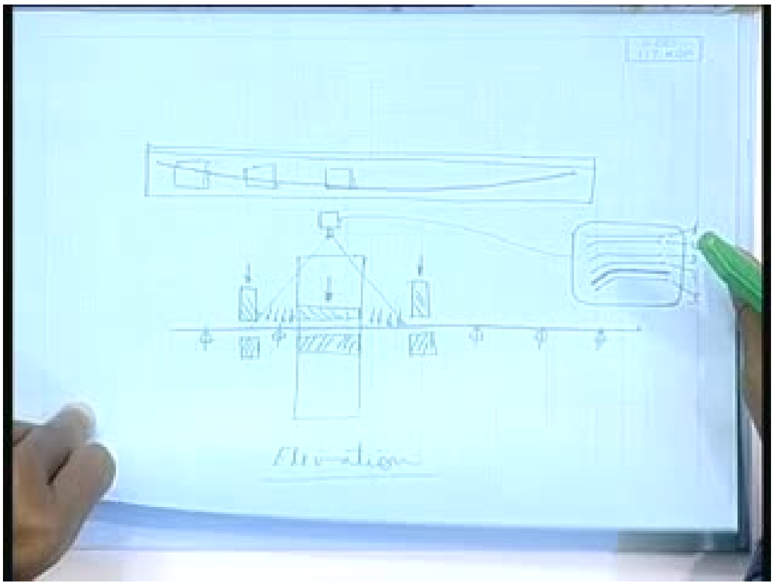

Some what a semiautomatic process means fitting of the thing will remain manual. Manual means it is not fully manual, there will be mounted on roller conveyors such that by actuating the roller conveyor, sitting - whoever is operating the machine, you actuate the roller conveyor. The frame gets fed, it moves in.

So, depending on the direction of the rotation, it will go from right to left or left to right whatever. So, that could be another solution of this frame bending that you can have somewhat reduced nonproductive time that is making tame plate. Bringing the tame plate putting it and checking it you see that also not only nonproductive time of producing the tame plate, the trouble of storing it and the trouble of using it. Using means what? Two persons will be needed that means one fellow will be operating in the machine, two persons will be maneuvering the tame plate; because, it will be huge one, two fellows will be holding from two ends.

So, three people are needed to bend one frame, so these all adds to cost. If one can do this camera stuff or if one can do this drawing, the curve on this thing, once it is drawn then a single operator of the machine can do the job, but it has its own difficulties and limitations. If I have a camera kind of a system, then a fellow sits in a more work - better work environment and do the job single handed - almost single handed. Just initially, probably you need some help of somebody to fit the initial positioning of the frame and then it goes single handed.

So, this could be one solution, wherein you can do the frame bending somewhat more effectively, but again what are the disadvantages? Prime disadvantage is to look at this camera such that it gets the clear picture of the edge. Because, here as I have said, this particular here, it will clamp on the web plate, so already so much is blocked, only this part is visible - only this part.

This small arrows I have drawn, probably those part are only exposed to the camera view. So, one can take only that much picture from that wanted to take extra polite and see whether it is matching or not. So, all this will be difficulties that means camera will not have a clear view of the frame continuously, because in this I will have to have somewhat continuously the clear view it should get; that is number one difficulty. That is physical location of the camera is such that it can see the edge which we are monitoring.

Number two difficulty would be, if it is an ordinary camera - digital camera, it will see everything, it will not only see the edge, it will see everything that means huge amount of pixel or picture information will be stored, so you will have to process that, filter it out, you need only this line - the edge. I am not interested in other, so it may call for a huge image processing capacity, which may lead to a difficulty in having developing a system which can do it online, because this has to be done online. Means, it is sees eventually it is there, the whole picture if I bring it here like in camera, you see that is of no use, I need that line.

So, from this extract that useful information, has to be online business that convert transformation - that computation from the picture pixel, what I am getting just that frame line that should be online. It should be able to do immediately processing, so there can be a problem of so called image processing, there by the capacity of the computers being used.

So, this is how we do it, these are the possible ways of frame bending in a mechanical method. Till now well that first one is used, means you manually bend it, you have tame plates that is most widely used, because all these looks nice, but not yet so comfortably it could be implemented. One can think of it if better algorithm to solve that problem of image or some other kind of exaggeration, wherein I do not have - I have some kind of monitoring the edge like using laser beam.

So, I scan that edge only with a laser beam, so I have only small information, but again all that is you to say that I will scan, but where you are using that, how the things will be covered, you want to get to see that. So, all these different problems are there.

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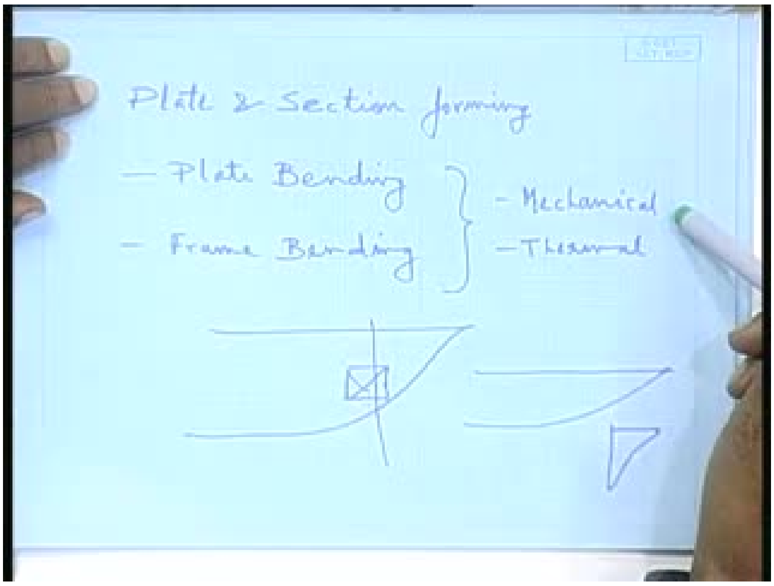

As far as this frame bending is concerned, then we talked about there can be methods of mechanical bending and thermal bending. So, may be in the same context we go for the thermal bending or may be thermal bending we will take it later, because let us talk about the mechanical one only. So that is what is three point mechanical bending of frames, now similar thing for plate. In frame it was easy, it was a two dimensional case, so a literally three point support. I mean one central support, two side RAMs moving, you could bend up the frames.

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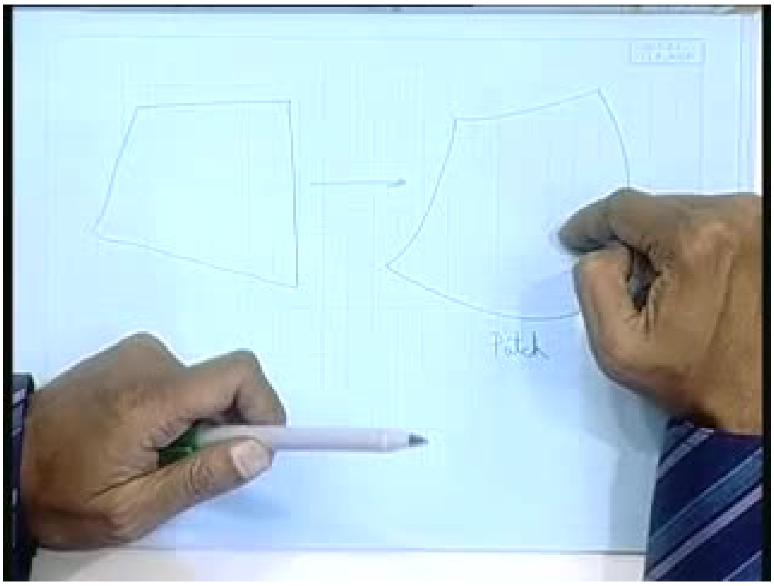

Now, when it is a question of a plate, so what happen? A plate is there, this probably is so called developed - two dimensional developed shape. From this you will get the curved section that means essentially this is the shape, which can be referred to as patch, because this is a patch on the hull surface. Definition of these we know, because once the hull surface has been defined or the hull development has been done, the lines plan has been done, so you have all the information of the hull surface.

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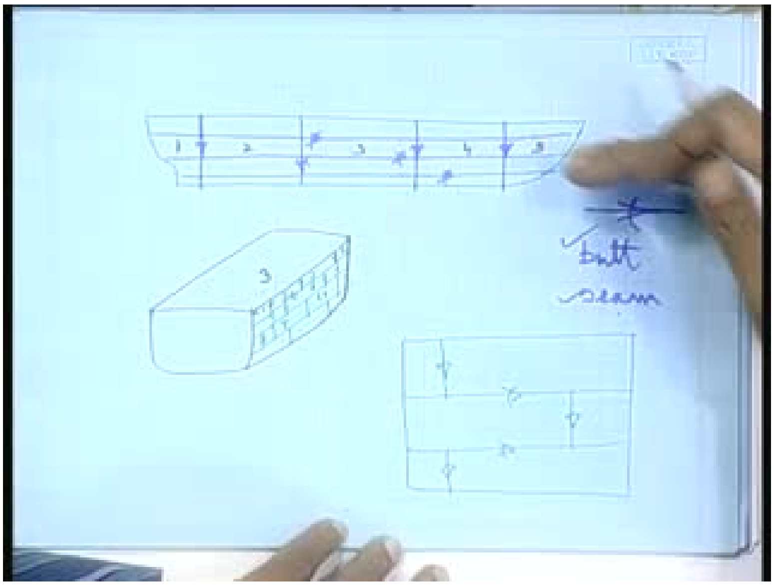

After doing the lines plan, you will have to work on the seam and Butt lines, that is there; that means where the seam lines will go and where the butt lines will come. So that it means, on a profile - this is my profile, if I see at a ship, we will see some lines like this, these are my welding lines, isn't it and such lines will be same. These are welding lines, there will be several of them depending on the height of the ship, depending on the plate we are using its width; there are the seam lines.

Also we will see vertical lines, various kinds of vertical lines in fact. These lines we are drawing, there are bulkheads or any such thing, they are the - let us assume that we have this particular symbol it refers to a welding line. That welding line could be either a butt line or could be seam line seam, but that essentially the same thing, but the difference is seam, when it is in the longitudinal direction this is referred to as seam, when it is transverse we referred to as butt. Otherwise, both are essentially a butt join that means two plates put like this and weld it.

So, here what I have drawn now is, I have shown some schematic seam lines and certain butt lines. That butt lines are coming vertically down that means we have assumed that we have built the vessel in blocks, say this is my number 1 block, this is number 2 number 3, 4 and 5 blocks; blocks means - say the number 3 block is nothing but essentially a block like this. So, in this fashion they have been built, so this is my number 3 blocks.

So, once the number 2 block is ready, you put it here and it is all round welded, so that is why I have a one welding line. In between the blocks, again you will have many this, well this seam lines and also various butt lines. Here you may see the butt lines may be staggered. They are not bricks, they are the welding lines, only thing what we have done, we have staggered it; that means say this is my number 1 plate, number 2, number 3, 4, 5, 6,7, so many. So, number 1 and number 2 are welded, then this is welded to plate 3, this is welded to plate 4, then 7. What is that? 4, 5, 6; 5 and 6 are welded, welded to 7 and then the whole thing is welded here.

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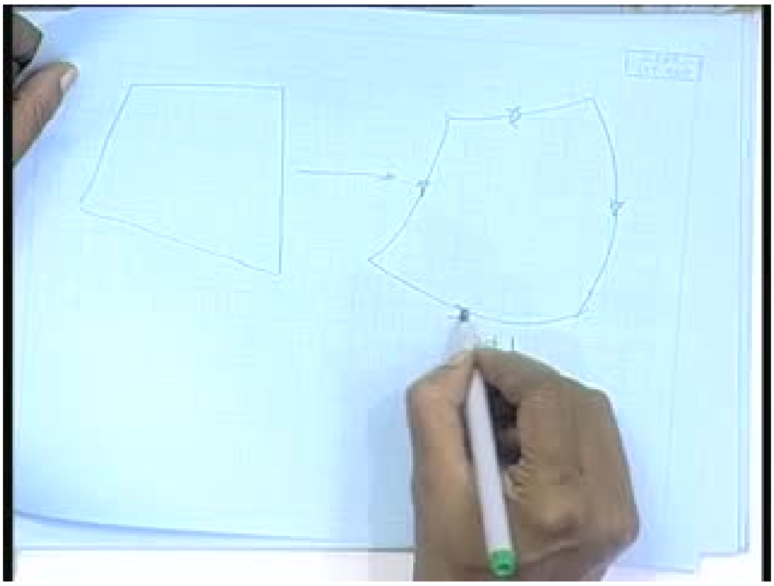

In other words, we draw a bigger picture, a part of the plate here we are drawing. So, these are my various seam lines, what I mean to say this will be full all over the ship. One thing, this welding lines, this seam lines, whatever seam line I am drawing here that should match with the next block also or in other words the seam lines also should be smooth, you cannot have one line here, then another gap again. No they should go smooth, otherwise plates will not match, in any case, we came to all these from that word patch. So what is this patch? It is nothing but, this is essentially my seam line that means one piece.

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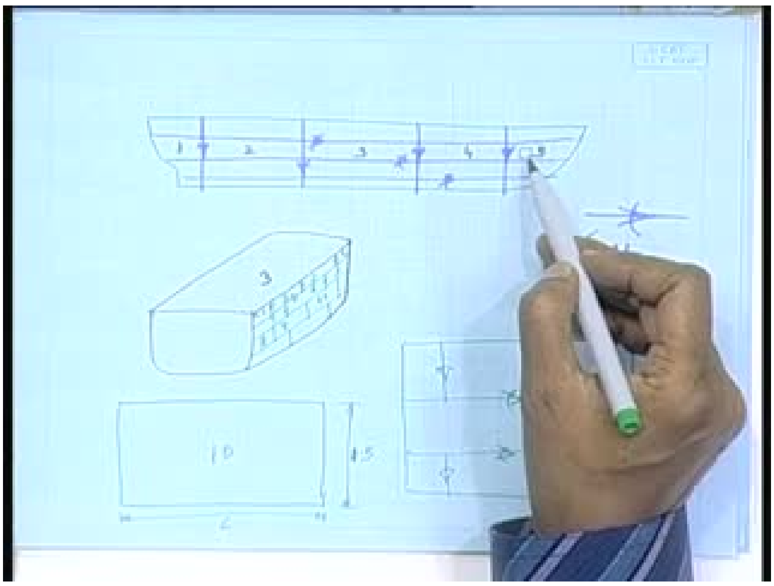

Say for example, plate number 10, the way I have drawn this plate number 10, I have said that it is a block 3. Plate number 10 is 1 patch on the hull surface, one piece of plate that plate number 10 is one piece, as I can see it will be very likely - it will be just a rectangular plate. So, you have nothing to do, only thing you will have to cut it, only thing you should know what its dimension is. We have to cut it out from those standard flat plates, 10 meter by 2 meter plate you have. Suppose this particular patch number 10 has a dimension of 6 meter by 1.5 meter say, so there is nothing is simple, it is put on a flat plate 6 meter 1.5 and cut it out, you have the patch.

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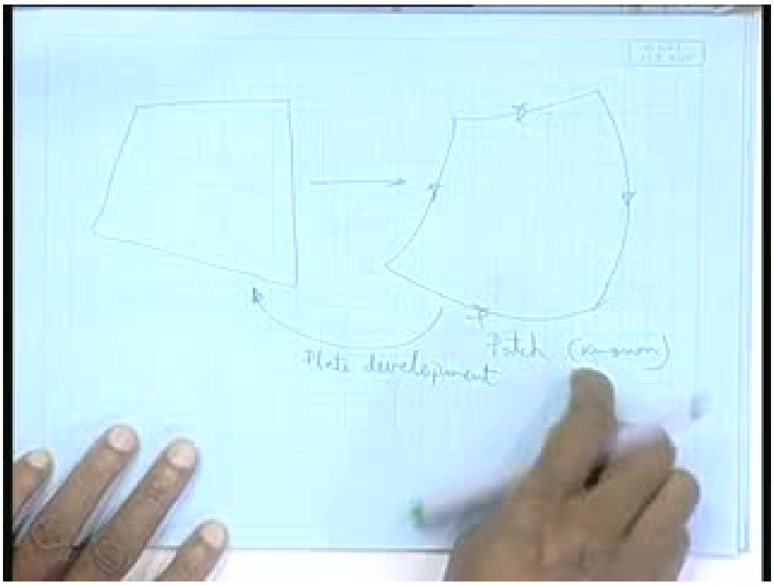

But, think of a patch here, in the block 5 that may be something like this in the block 5, a patch of the plate; that means, here also I will have all kinds of this seam lines, butt lines and all that. So, one piece there if you take out, it may be like this, means a curved plate, so that is what it is called patch. Here, this is my patch, it is a flat, there is no further operation needed that means I do not need to develop it, here it has to be developed, means from here I have to first get this shape.

This is plate development, this is known, this shape is known, because I know the hull form, from that I do this development - plate development. You know you have a cone; you have done in engineering drawing plate development, you open up the cone, what you are basically drawing? You are opening it up; if a cone is developed how it looks like?

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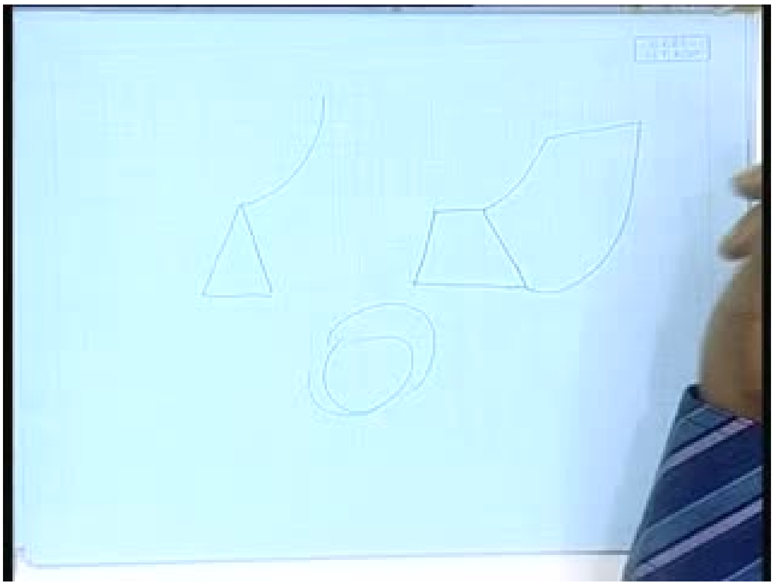

A first term is opened, it will be something like this, you roll it, you get the first term - a trunk headed cone. Right can you develop a football, volleyball, basketball, can you develop yes or no; no it cannot. If you closely take a look at those balls what it is made of? A pentagonal patches are there, generally pentagonal patches are there (( )). These I do not know, may be hexagonal patches also there, whatever some patches are there, if you take a even closer look, those patches are essentially flat, so how do you get a smooth spherical curvature? How do you get? At the joints they are at the joints they are like this, the knuckles are there, sort of that. That means that is why you have a balder there, you go on pumping it, what you are basically doing? Because of Pascal you are getting uniformly forces everywhere.

So, at a certain stage, you will find it has become just tot, means this curve - this knuckles will be visible. Knuckle mean, where two flat sections meet, flat surfaces meet, this is one patch, this is another patch, those pentagonal hexagonal patch this will be go on increasing the pressure, slowly you will find this is no more visible, it has truly become a perfect sphere.

What has happened? It has stretched that means you have built some stress strain inside. You have stretched that leather, it has been stretched and you got the developed surface. So, a non-developable surface if you want to develop, you will have to impart a strain in, you will have to stretch it then only it will be developed.

But a developable surface you need not put any strength. A cylinder - this is a cylinder, it has developed a rectangular piece of plate, it is just rolled and you get a get the cylinder. I have not put any strain in the plate that means the circumference of the plate. This section cross section will be equal to the length of the plate, but the circumference of the football will not be equal that and will be more. If you really cut the thing and put it flat, it will be less, so a bit of stretching is needed.

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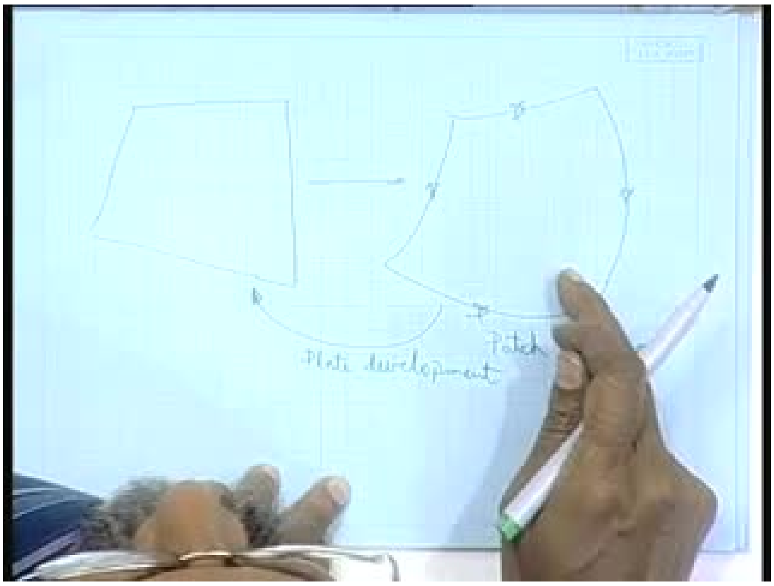

So that is how we come to the concept of Gaussian curvature, non-Gaussian curvature; details you will learn later. When you learn more about surface geometry, a non-Gaussian curvature is non-developable. Any way those things we will learn, we would not go in those now. So, this patch I have purposely drawn, which is a non-developable surface means having or in other words, we say a plate having double curvature.

Double curvature means in x y plane there is a curvature, also in x z plane say there is a curvature x. Let us assume x is along the length of the ship, y is along the breadth, z is along the depth, so what is happening? x y is the water plane, so in the x y you have the water planes like this, isn't it, the water planes they come like this.

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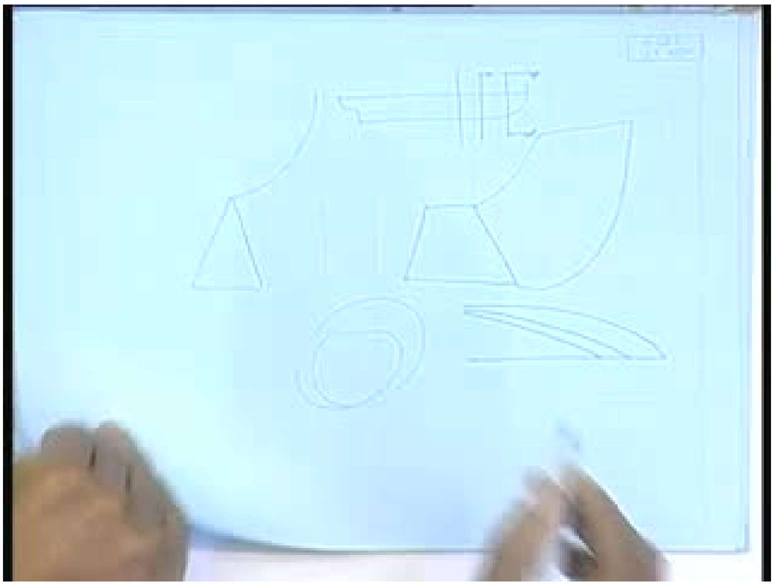

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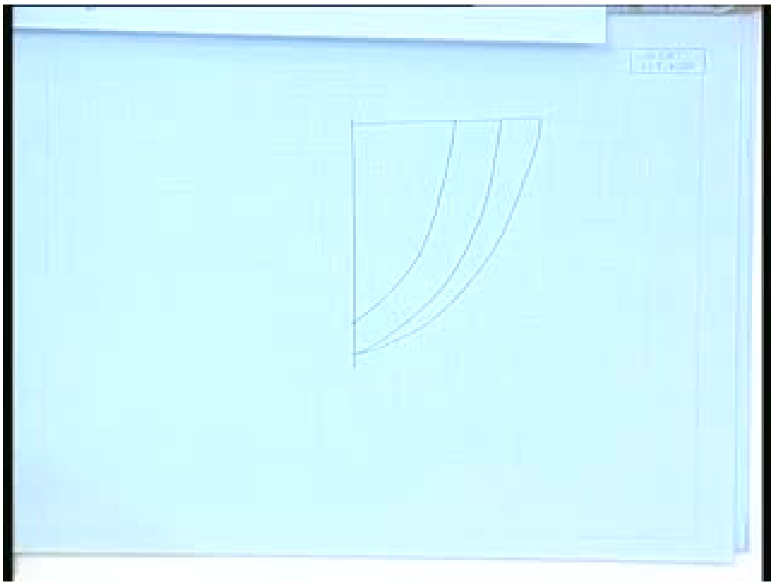

This is curvature, if you cut the water planes with a horizontal plane along the depth, there is a curvature. The frame planes are the vertical sections, they are essentially y z planes, the vertical sections and they are the y z plane that means the section here. Whatever x z plane - any way that means basically the frame planes, so they are coming like this, so it is curved in this plane and curved in the horizontal plane also; the plate is doubly curved.

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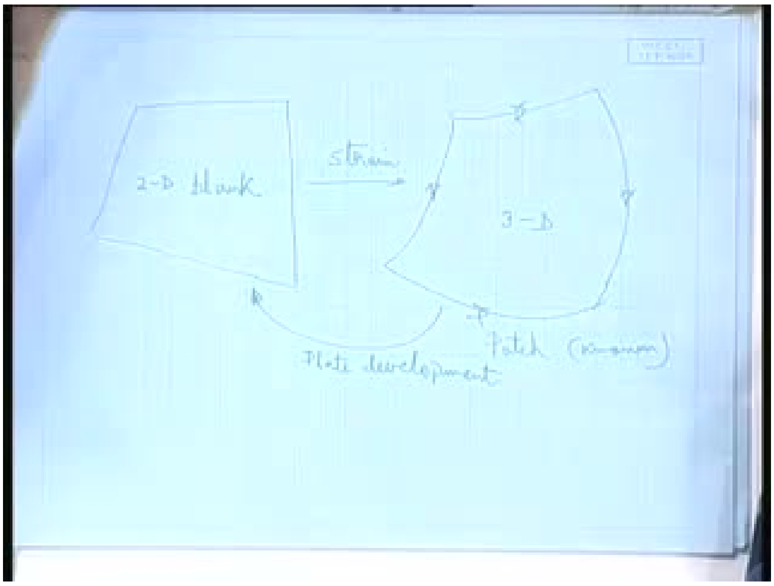

That is what we say that if there is a double curvature in it, like roughly I have tried to draw here, it is curved in this plane, also curved in this plane, so whenever you have a double curve plate that also has the same problem of it, becomes a non-Gaussian curvature. It cannot be developed easily; developed means developed two dimensions, so this is what I have to go for a plate development process.

That means a certain kind of strain has to be taken out. In this case, as if the strain is taken out, then it becomes a two dimensional shape. So, this my 3-D patches, this is my 2-D, this is referred to as blank - two dimensional blank. This two dimensional blank, I will cut out from my rectangular standard plate, then put the required strength subjected to the required strength, I get the patch.

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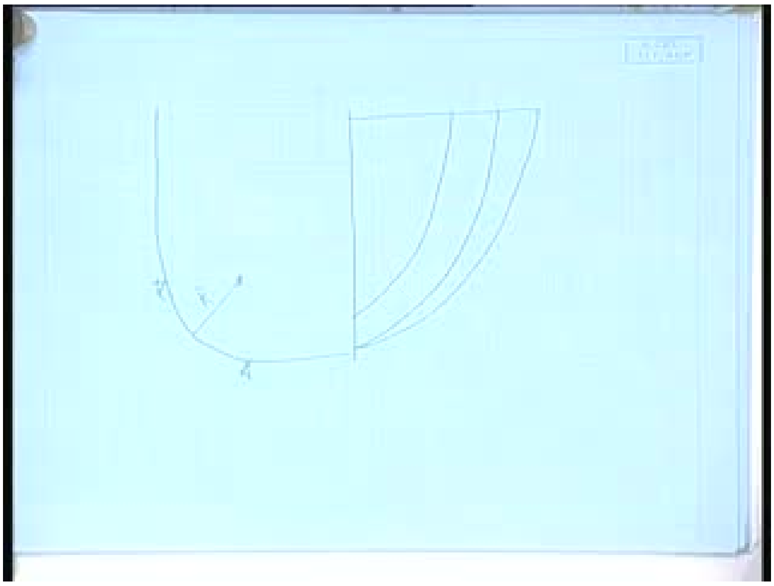

So, plate development is little complicated, I will have to get to know first the blank, I will have to get it properly, so that is what is to be done in so called shell development - shell expansion. I by the work of shell expansion in mould loft, these days thinks are little easier, you have all kinds of software's, through which once you know the 3-D patch, the geometry it can be done 2-D blank is octant; but now how to apply that strength ? If it is a developable surface, say the bilge plate.

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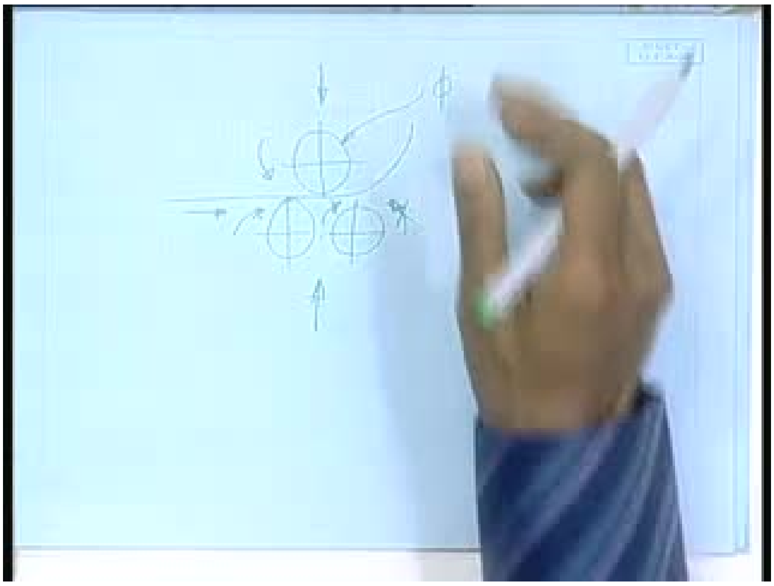

It is not much of a problem - bilge plate, suppose this is my bilge plate - bilge plate is generally is of a radius of curvature that means what? A part of a cylinder, so bending of such things is easy, is done by passing the plate through roller. In the first stage, we have passed plate through rollers to straighten it, now we are passing it through rollers to bend it. So, there will be difference in the roller arrangement, now it will be like this.

For straightening we have seen five roller machine, we have seen twenty two roller machine; here, it will be only three roller machine, two on the lower level, one at the top. So, you will apply the force, they will rotate in this fashion, so as you fit the plate dipping on the gap between the top roller and the bottom roller - the diameter of the top roller, this is important- diameter of the top roller, you will achieve the radius of curvature of the curved plate of the cylindrical plate. So, if it is a cylindrical curvature, the bilge plate, it is not a big problem, by simple plates rolling you get it very fast.

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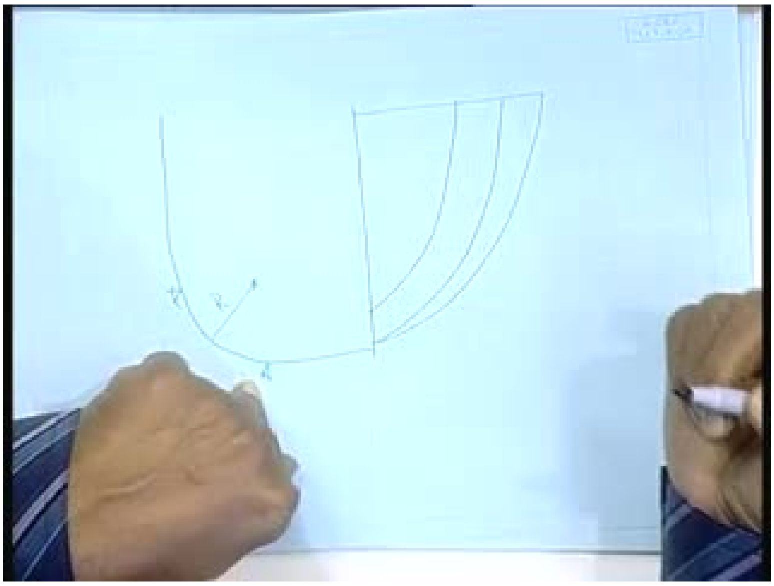

Only thing whatever is the bilge radius, to achieve that bilge radius, you should have a rolling machine, whose top rollers diameter is suitable to achieve a 4 meter dia radius - dia curvature; some suitable curvature of this roller is needed. So that is an easy operation, there is no problem, the plate development is also not there, because it is part of a cylindrical this thing, so it can be easily - you know butt size of plate. That means if this is my patch, the blank is very easy to generate, once you have - it is a rectangle once, the blank is there, pass it through this, you get that.

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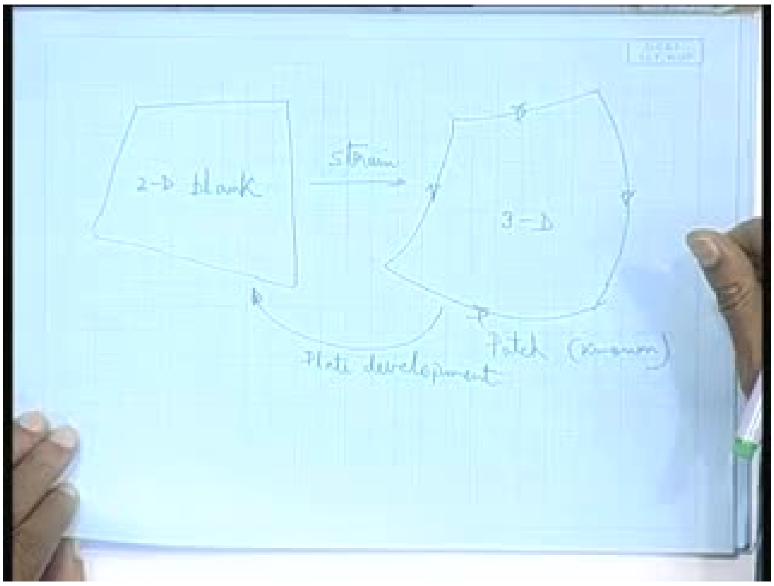

But here, it is little more complicated to get that. You will have to apply the strength and then get the 3-D patch. So, we will see how mechanically it is done and subsequently how thermally it is done.