Design of offshore structures
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Module - 03
Lecture - 01
Steel tubular member design 1

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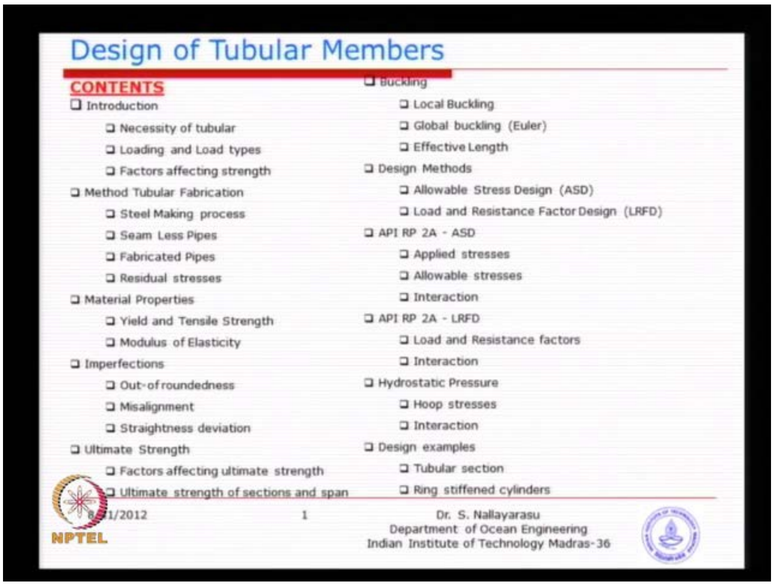

Is this font too small, I think it is ok, this is may be the table of contents is too many things put together also this thing is this little blurred because of this. So, let us start the third module basically the design of tubular members, now what we are going to do in this module we have to cover little bit background starting from basics of mechanics. Then basics of materials how these tubular are made and then the properties of these materials, how they are derived and what are the imperfections involved in the manufacturing process of pipes and assembly of structures.

Then finally the ultimate strength of assembled structure, so that we can apply a factor of safety to arrive at the allowable strength, so we are just going to go backwards little bit. So, that you can get because I am not very sure what background all of you have, so that we can go little slow on this because this is most important topic then we will introduce the buckling.

Some of you might have already got some knowledge of buckling then we will introduce the design methods allowable stress and the limit state design. Then we look at the A P I as one of the criteria because most of the offshore structures is designed as per the A P I code. So, we will both look at both the codes see how they differ and then we will take at one of the code which is the allowable stress design and follow the design process, carry out few design examples.

Including the design for the hydrostatic pressure which is definitely the new one compared to the onshore structures and then we will try to do a few examples with and without stiffening effect, so that we can understand the difference. So, it is quite a large topic I do not think we can finish it before the start of the quiz 1, but we will try to see what can be done before that, so that it can also be included in the exam.

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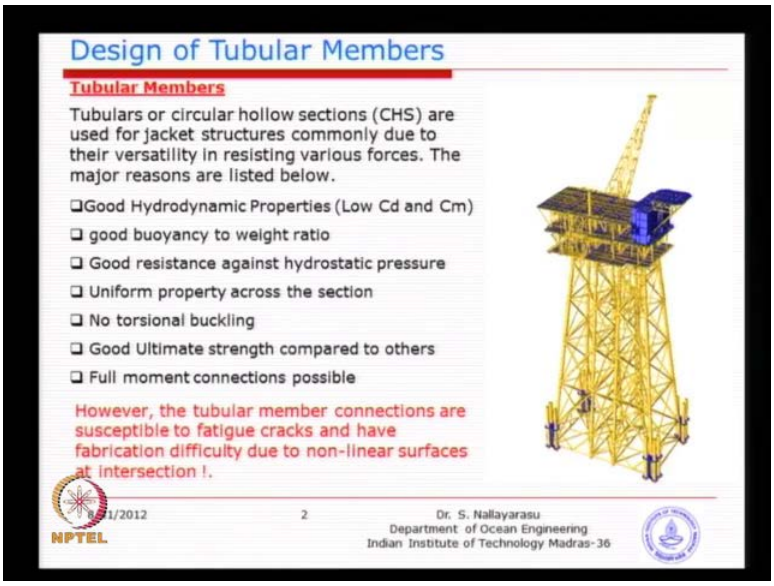

So, if you look at this picture and the right of what you can see here basically why we use always tubular members in offshore structures you may not be knowing, but I can tell you for sure 99 percent of the structures that goes into offshore systems. Especially, for fixed platform structures we normally use the tubular sections for several reasons that we can discuss one by one, one of them is basically the hydrodynamic properties. I think we have already compared that last time when we were reviewing that C d C m coefficients for various shapes circular and non circular shapes.

You could see that they do have if you see in terms of reduced hydrodynamic loading basically because of the shape of the body. That is why it could potentially reduce the loading means the requirements and the cost associated with the platform could be lower because you can minimize the structure size. Second one good buoyancy to weight ratio which is very important, very similar to the aircraft structures what you require is strength to weight ratio the more weight is more problem is not it.

So, basically higher the strength lower the weight is good for aircraft structures whereas for us we need definitely buoyancy of course we do also need strength to weight. But, as much you also need buoyancy because the structures needs to be installed offshore during the process we require buoyancy for sure you take I beam and you take one circular section. You compare the buoyancy of an i section compare to the same weight a tubular section you will see that the buoyancy for tubular section will be same. But, of course when you look at the strength it may not be that efficient because if you look at I beam it is very good for bending, but not very well for axial loading.

Whereas, tubular is good for axial loading buckling may not happen but, it may not be that good for bending still it is reasonably good, so we need to see what property offers the best form of a strength. Then the third one definitely a good idea good resistance against hydrostatic external or internal pressure because of the circular section can take more pressure compared to a rectangular or a square section because of the arch action. Uniform property across the section for sure you will all of you will know no torsional buckling I think some of you might have studied torsional buckling is one of the big cause for concern in terms of open sections like I sections or channel sections or angle bars.

When the loading is still applied on the cog of the system the beams may twist along it is axis due to a term called torsional buckling we will discuss this torsional buckling when we start looking at the open section design not at this stage. Good ultimate strength compared to others this is what we are going to in fact derive when you look at I section. When you look at a rectangular section and look at the circular section circular section offers a so called increased strength compared to the other sections that means you could actually take a higher risk.

That is exactly the idea and moment connections is very easy to make compared to other forms of, so there are plenty of reasons why we should use this circular sections. So, you can see, here there are some disadvantages of course that is what we are trying to overcome when you select a tubular section what happens is it creates difficulty in making welding for sure.

You got a surface that is continuously changing when you make a pipe to pipe connection is not a flat plate to another connection. So, you have a little trouble mostly we face problem with welding and associated cracks associated fatigue and then we may spend more time more effort in trying to correct them. But, since we have so many advantages we may ourselves do some additional effort in order to overcome this problem.

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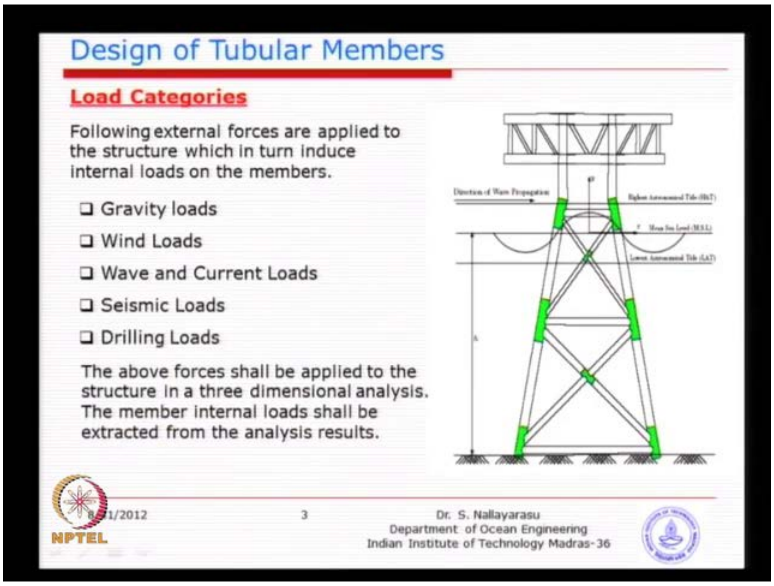

So, what are the loads I think we have discussed the loads earlier so many times gravity loads, wind loads, wave loads and seismic loads drilling loads. So, basically all these loads are subjected to you know with different combinations of occurrences, not all of them going to occur at the same time for example environmental loads and seismic loads may not occur at the same time the maximum.

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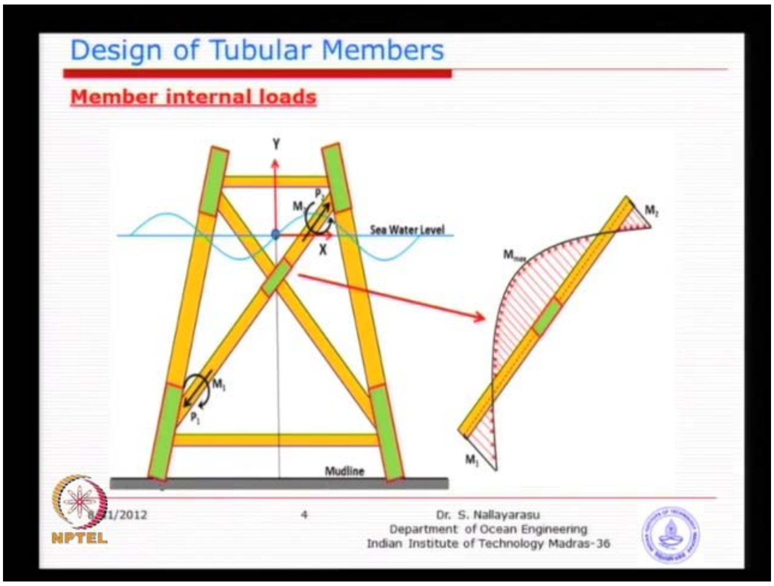

So, what is the member design load or so called member internal loads what we need to do is carry out a 3 dimensional global structural analysis I think nowadays with the help of computers you try to carry out such type of analysis, extract the forces on each individual element. Basically, you may have actual load you may have bending moments you may have shear you may have torsion you may have hydrostatic pressure external because these members are not flooded.

So, they are hollow and they are made buoyant inside that means you may have external water pressure all the time while the other forces are acting at the same time, so we may have to design all these combination of forces. Now, when we extract these forces the force may or the moments may get distributed in this form we do not know what is the form it could be this way or it could be single curvature bending or double curvature bending we do not know before we actually extract the forces. So, we cannot decide how we carry the design process for this member that means if I take the maximum moment at this point for example looking at it looks that is the maximum.

So, I go and search for the maximum moment on this member or that point and corresponding section at this point, so I take the axial force and corresponding shear force corresponding hydrostatic force and design it will it be safe. We do not know because this point the elevation at which it is somewhere here hydrostatic pressure may be not maximum there because hydrostatic pressure is proportional to the location from the surface of water. So, we will not be able to decide just based on one information called maximum moment that the member will be maximum stresses subjected because of that.

So, what we really need is take these distributed forces on the member it could be 10 meter, it could be 20 meter divide the member into several sub segments could be 10 pieces could be 20 pieces. Each piece you go and look at the corresponding forces axial bending shear and design, so you repeat the process throughout this member and find out which one is a highest stress. That will be the governing case and repeat this process for all possible loads or load scenarios, see basically when you analyze a structure like this I think we have discussed the 8 wave load direction needs to be selected for any particular structure.

So, that means at least you will have 8 sets of loads because each time the wave direction is different and each time the gravitational forces the combination of them is different sometime live load may be there sometime live load may not be there. So, all these scenarios, so the design of one member means you have to repeat the process of load cases or load combinations and divide the member into sub segments at least minimum 3. If you look at this bending moment diagram I can tell you for sure at least one at the center 2 at the extreme ends for sure is required you take any beam you look at the bending moment distribution of a pin pin beam simply supported.

You will have definitely the bending moment is maximum at the middle when you look at a narrow beam you may have a bending moment maximum at the center or may be at the extreme ends. But, reasonably for a U D L or a point load you have some idea what type of, so 3 points minimum is required, but then if there is a complex set of loading we do not know whether the minimum diagram is like this. So, it is better that we take slightly more may be five or may be 10 because nowadays everything is done by computer whether its 5 or 10 not making a big difference.

So, you will have to divide the member into several sub segments each time you just check the stresses at that ten points and whichever is giving you the highest. Based on corresponding loading you do not take the maximum moment here and a maximum axial force here we cannot combine they have to coexist you understand the idea know so that is the basic understanding. Then when it comes to global behavior of the member you cannot take the small segment you need to take the full member for example buckling length.

You cannot take that segmented member you have to take the full length of the member from here to here because that is where the boundary condition. Where the supports are provided only for the purpose of trying to evaluate the stresses we divide the member into sub segments. So, the internal loads have got certain notations depending on right hand system or left hand system what I am using is all right hand system, so axial forces towards the joint will be compression and an axial force towards the center of the member could be. So, that is again depending on which system that you are trying to follow based on sometime different softwares uses different notations and sign conversions, so you have to be little bit careful.

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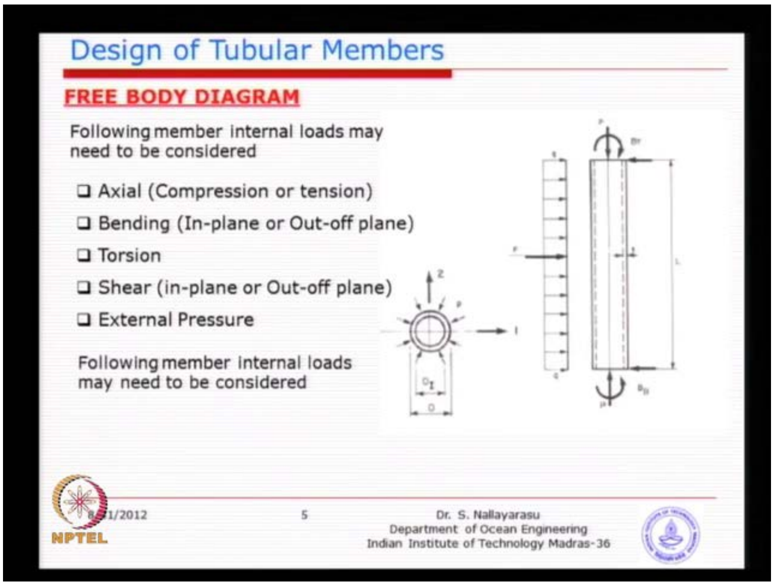

So, the free body diagram what we are trying to make is what are the forces applied on its simple element what is the meaning of design is basically trying to assess the capacity of the member with respect to the external loading the external loading is shown here. Now, this process should be repeated for all the members in the structures, so if you go back to the structure in a plane I have shown only 6 members something like this. You have to repeat the whole process for all the members in the jacket, so that every one of them individually safe and the assembly of the structure will be safe when you do a system analysis.

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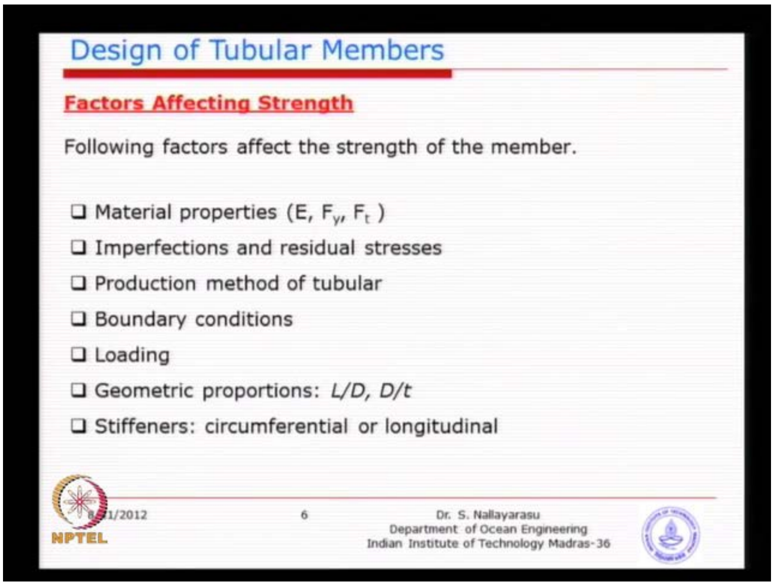

What are the factors that are going to affect the strength of any structural member basically we have material properties I think most of you will be familiar material properties. The most important one is the modulus of elasticity the characteristic material property which describe the behavior of the material during the loading process, so how much strain how much stress and the initial portion will always be linear. That basically we are interested in that, the second one is this, the yield strength and basically beyond which for allowable stress design anyway we are not going to use.

But, the tensile strength is basically the ultimate strength of the material at failure then the imperfections and residual stresses you know we have to learn what are this something new. Basically, when you take a piece of material to form a pipe the pipe may be coming from the mill or the pipe may be made out of steel plates during the process when you actually take a flat plate and then bend it to form a plate from plate to pipe. You may actually induce stresses even before the structure is subjected to the external forces from the service.

So, those types of stresses are called residual stresses induced during manufacturing process assembly fabrication process which are before the structures are actually subjected to the service loads. The imperfections are something that always bothering us because the construction is a man made activity, so you always will try to minimize the imperfection in the construction. But, unfortunately we cannot make it 0 for example you want to make a circular section from a flat plate you take a flat plate and then roll it 2 half segments, 2 semi circular arches and try to do a welding like this.

So, when you look at this cross section if it is 100 percent circle the imperfection is 0 that means the circle or the geometry that you used in your design is circular section. So, same has been made and you are happy because the simulation what you have done before for design purpose is satisfied by the construction with 0 tolerance, 0 error. But, if they are not able to make for sure everybody has their own limitation every contractor or every fabricator every machine has there is no machine with 0 tolerances. So, you will be able to make the fabricated steel with some tolerance may be 1 percent error, 2 percent error, if it is 10 percent error probably not very good.

So, we need to just allow in our design that we say you can accept a 2 percent error you cannot say I will not accept an error of any kind because then fabrication becomes quite tough. So, these imperfections for example when you made a design calculation using a circular section and you have used all the geometric formulaes for circular whereas if they have made an ellipse. So, what happens so basically 1 percent error, 2 percent error the larger the errors the deviation of your calculated stresses are higher. So, what we need to agree a percentage error in the fabrication which will happen after your design the design is done first the fabrication is going to be done later.

So, what we are planning is accept an error of say two percent during the design process, so as long as the fabricator or the construction contractor is able to produce that construction within the 2 percent tolerance not required to redesign or review the design. Whereas, if he makes a mistake beyond which you would not be able to accept probably you will have to reject the construction or redesign and review the design process normally we do reject it because review means what else can be done. So, these imperfections are something that we need to see what exactly is going on during the construction process and try to remedy by allowing bit of tolerance in the design process.

That means instead of taking a sectional property corresponding to geometry of circular section you may actually consider a deviated property in the design by somehow some correction methods. Say for example if you have a circular section area of it is hundred percent and if you make it as a slightly deviated circular section what reduction in moment of inertia comes because one of the axis become weaker. It could be another 3 percent reduction or it could be 5 percent reduction, so in the design calculation process you allow for 5 percent reduction because of imperfections.

Residual stresses a very similar idea when you actually make a pipe from a plate because of the bending you have a bending stress induced. So, when your design process you reduce the yield strength by 5 percent to account for the pre stresses which are already inherent in the pipe. So, that your design becomes, so these are some things that we need to take into account and we will also look at the production of tubular look at the boundary conditions because as you know very well. The beam or a column is highly influenced by the support conditions with regards to its capacity production method we will see.

Basically, the way that we make pipes and the way that we make steel, so you just try to understand for few slides and then the type of loading for sure they influence the capacity. For example, if you have a column axial load and the horizontal or the lateral load could change the way the column behave, so basically the loading type loading locations loading magnitude and loading direction. So, basically the all those things will be required to understand then the geometric proportions geometric proportion is the most important one in terms of design.

Basically, the length to the diameter ratio in this case if it is I beam it is a length to depth ratio mostly you would have seen the longer the span the depth of the beam is bigger. So, typically if you look at a concrete beam for a bridge span of say 30 meter you might have seen in some places probably more than 2, 3 meters. So, basic idea is larger the span bigger the depth just to tolerate the deflection issues sometime you have might see in the design codes like R C design codes. They would give you the span to depth ratio is somewhere around 20, 15 depending on type of design type of material for a simple R C construction what is the span to depth ratio for a simple beam.

Student: 20.

20, so I think if it is a cantilever, so you could see that is becoming half simply nothing else 2 cantilevers joined together is a simple beam. So, if it is a 20 meter span you definitely need at least 1 meter depth of the beam is not it that is the meaning, so the 30 meter you need 1 and half meter. So, you could see that you cannot go and put just 200 millimeter beam for a 20 meter span is all common sense by past experience you could never design a R C beam with 500 millimeter and 30 meter span for sure you are not able to even if you pump in as much steel.

You will see that still there will be a deflection problem unless you make the beam itself fully steel no concrete then probably you could you could. But, still even for steel beam 500 millimeter versus 20 meter is not at all feasible, so that is where, so the minimum dimensions this comes normally by experience by guidelines by past design examples. So, you will be able to fix the geometric proportion purposely you do this because you start with a wrong dimension. You may actually end up with wrong dimension also because your starting point you are going in a wrong direction it might take several iterations before you actually come to a conclusion.

Then for this specific case of circulars sections especially the circular hollow sections we need to worry about the diameter and of cell thickness the larger the diameter the smaller the cell thickness we have a problem of local weakness. The cell will be not able to withstand because we do have an external pressure number 1 and we may have an axial force which could actually potentially make the cell to become unstable. Even before the global load comes it actually become wobbly may fail by local buckling, so basically that is again by a virtue of past experience plus the guidelines from the codes will tell you what should be the minimum D by t diameters to wall thickness ratio.

You suppose to be using at the same time if the D by t ratio is very big for example you take a 1 meter and 100 millimeter thickness. So, what is the D by t ratio is about 10, imagine you take a 100 millimeter thick plate 100 millimeter is about 4 inches and I want to bend it to a half a meter radius to get a pipe I have to bend it to half a meter radius. Now, what you can see here you do a simple bending stress calculation you might have already studied in your elastics theory M by I will be equal to E by R. You substitute this you will find the bending stresses induced on a 100 millimeter plate to bend it to half a meter radius could be substantially high.

That type of stresses can cause the final strength to be reduced because already this when you fold it you have already induced an even before you apply external loading not a good idea. So, what we need to do is we need to see what should be the best D by t ratio that this should go low and go high does not mean that we keep on making thickness. You look at that D by t ratio of 10 you will see that the weight and buoyancy will be not very good weight is very high buoyancy will be very low. So, basically both these parameters play a major role in deciding what parameter what wall thickness and what span suitable D by t ratio along with a length should be selected.

Sometimes what happens is if these hollow sections become too wobbly like what I said D by t ratio of 100, for example 1 meter diameter 10 millimeter wall thickness D by t is 100 you may actually fail by either by local or by global. So, what we can do is we can try to strength and by means of stiffening additional stiffening can be provided you could ask a question why we should do this why not we go and change to 20 millimeter could be potentially possible. But, as a designer you could see that this could be economical later we will prove or there could be a situation where already the plates are already purchased.

So, you have to go for a stiffening design then getting and asking for a new material, so all this manipulations can be done. So, you could see that this the factors that they are affecting the strength starting from material all the way up to fabrication manufacturing process of pipe and then loads geometric arrangement and finally the stiffening effect. Now, you can see when you want to use assess the allowable capacity or the capacity the maximum load that the structure can take you need to go through each one of them and take into account.

Each one with some representative parameter for example when I go for imperfection I would say that diameter deviation can be 2 percent. When I go for residual stresses I can take a reduction in the yield strength by 5 percent to account for x y z fabrication related issues boundary conditions each type of boundary condition you need to assess separately. So, what we are looking at is each one play a major role and finally you will get the strength effect or, so called the resistance of the structure against external loading, so we have to go through one by one quickly.

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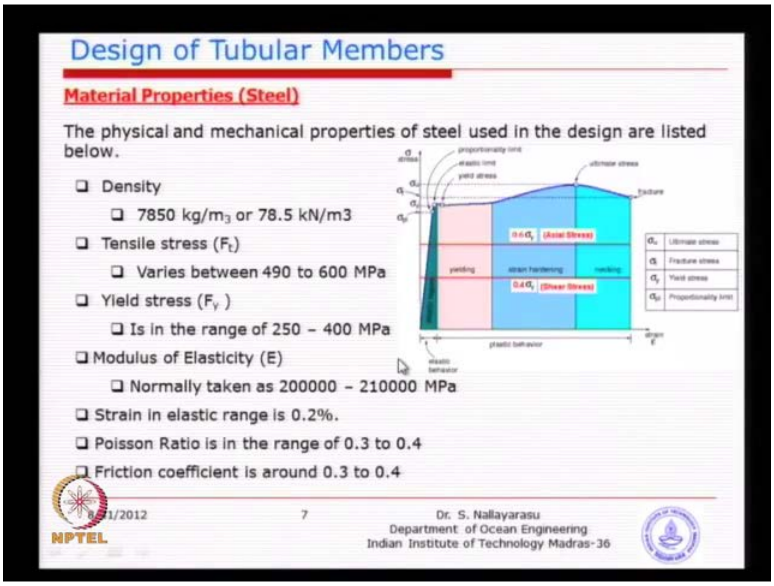

So, if you look at the material properties of steel I think all of you must remember these numbers at the end of the day you should not go without knowing these numbers when you graduate out sometimes I think I am hearing from people. When you people are going for interview you cannot even answer such simple questions, so you should be able to keep it in memory. In fact few times it has already happened you know basically the density tensile stress yield stress of course the yield stress differs depending on type of steel whether it is a mild steel high strength steel alloy steel.

So, the range is typically from 250 mega Pascal to and 400 mega Pascal, off course you do have steel beyond 400 mega Pascal for offshore application as well for structural fabrication. We do not go beyond 400 the purpose of which is basically the welding is the problem if you go for high strength steel you have a problem with welding. You will be able to substantiate the reason behind because normally the mild steel or so called steel is a low carbon steel material. As you increase the carbon content you might increase the yield strength slightly, but of course not without adding additional alloys.

So, what happens when you increase the steel with higher carbon content with additional alloy material the material becomes too difficult to weld? So, you need to come with a special welding process which normally the offshore industry is not very much interested. So, that is why A P I does not recommend any material with yield strength greater than 400 mega Pascal normally we limit ourselves to 400 mega Pascal and tensile stress basically varies from 490 to 600, 650. Then the modulus of elasticity 2 into 10 power 5 up to 2.1 into 10 power 5 most of the time we take 2.05 into 10 power 5 as a representative value for most of the steel you will see that strain at elastic range.

So, all of you must be familiar with this graph what you see here I think you should have seen it before during your mechanics time a typical stress strain curve for a low carbon steel. The reason why I call it low carbon steel basically the range of yield stress is between 250 to 400 and basically you see here the first part is the elastic part. You have a linear relationship between stress and strain until the proportional limit and then the yield limits, then you have a plane to where strain hardening is happening with the ultimate point which is the ultimate stress or the breaking point or you have tensile stress point.

So, basically what we are looking at is what difference it makes when i make a design the load effects versus strength effects the load effects is going to be our displacements and stresses and where do we stop. So, if you look at this diagram for example yield point is somewhere here after which it becomes almost horizontal without even any further loading you see a plastic deformation that means after reaching that much load. The structure is going to deform substantially larger amount without any increase in loading, but after certain loading change from the plastic behavior to slightly pick up that additional load that particular aspect is called strain hardening or the redistribution behavior of the material and the structure.

So, it is going to actually redistribute take little bit further load, so this is what we are actually very much interested in terms of ultimate strength. For example if you take another stress strain curve if it is going flat 100 percent not a very good material because immediately after yield what is going to happen is the structure is going to fail immediately because there is no more sustainability of the system because you have this slope. Here, which can take further more load that means the structure will not fail immediately, so that is what the major difference any material selection when you are doing this.

Basically you need to see the post yielding behavior after the yield point how the material behaves is very important because if it is a flat steel stress strain curve something like that is not good steel because it will be continuously yielding once it reaches the yield point. Poisson’s ratio friction coefficient all of them will be quite useful, basically while we do design later on, so what is very important is the strain in elastic range is point 2 percent. So, this point is point 2 percent when you look at this point it could be 10 percent.

So, you could see that the steel fails and breaks typically this is taken out of a tensile testing experiment you take a steel rod of a specific specimen size go to the universal testing machine start pulling out from both ends. So, you could see here at ten percent strain the steel breaks into 2 pieces, whereas what we are normally going to use the design is limited to less than 0.2 percent. So, you could see that we are using only a smaller portion of the characteristic strength available because we are very much afraid of going anywhere here because these structures you cannot allow them to deform during its service.

So, much which could actually become a problem for the service conditions for which they are designed, so that is why most of the structures we have designed within the 0.2 percent strain. Whereas, the actual structural capacity could be very large, so these material properties very much necessary to be understood carefully, so how do we get these all properties most of them by experiments. For example yield strength of the material you arrive from piece of steel is taken take to the testing laboratory and you do the testing and get the results of course it is a large structure.

Then what we need to do is you need to sample it at several points for example when during construction of concrete structures normally you take a concrete sample take it to the testing machine sample is made into a cube when you do a compression strength test to arrive at the strength of the concrete. So, very similar for steel structures you have to take piece of samples from the plates which are used for fabrication of jackets then do the testing. Then arrive at whether that strength of the material is same as what you have used in your design if it is deviating then there is a potential problem how much deviation you could allow.

Typically, like our imperfection if the strength you have used is 350 mega Pascal and every piece of steel that you bring from the purchase from outside to use in your construction. You suppose to test every piece but, imagine testing every piece could potentially become too slow to use them for construction purpose because unless you have competed the testing the plate cannot be used for the construction. So, it could be potentially a costly affair normally we do a sampling, so many tons you do one sample very similar in terms of concrete construction we actually have a requirement from the codes that every 100 cubic meter.

You have to have 1 concrete cube as the sample that represents that mass of concrete which could potentially either way it could be it could be not depending on the quality of construction. So, that is why when you buy steel, you better buy from a good quality mill that you do not need to really test everyone of the piece that comes from there. The sample will represent that the steel is good quality always the yield strength is going to be higher than your expectations if it goes other way round potentially your design is good. But, the construction is not very good so basically that gives you an idea about the material characteristics.

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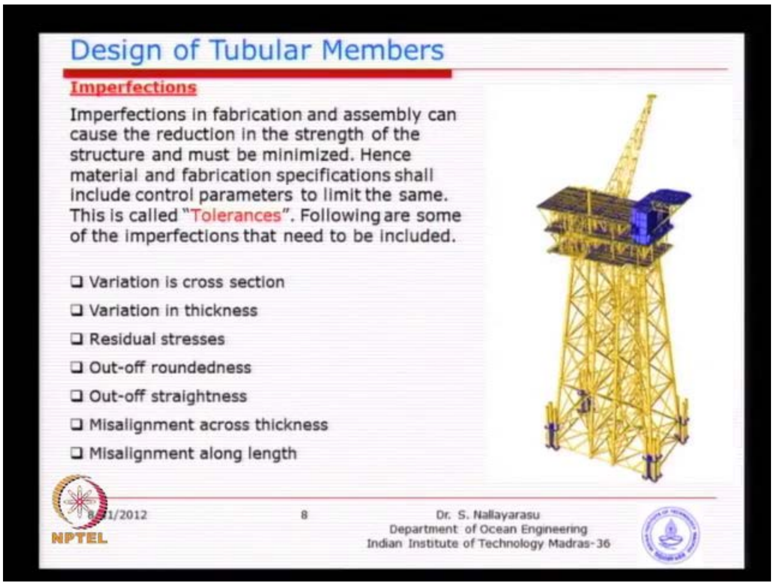

Imperfections I think several of them starting with a variation in cross section which we discuss about it variation in thickness which is potentially another problem residual stresses out off roundedness out off straightness. You know you might have seen in the construction process they try to always use the plumb to find out whether the column is straight upright orientation right. So, there are several checks required to make sure that the design assumptions of a column perfect column when you are talking about design misalignment across the thickness misalignment along the length.

So, quite a number of things can happen I have just listed only few of them not necessary that we need to go exhaustive which you could find it from the code guidance. So, these are called tolerances the reason why we need to allow tolerances is very simple 0 tolerance you could possibly not may not possible to construct the structure because every machine and man have their own tolerances for any execution.

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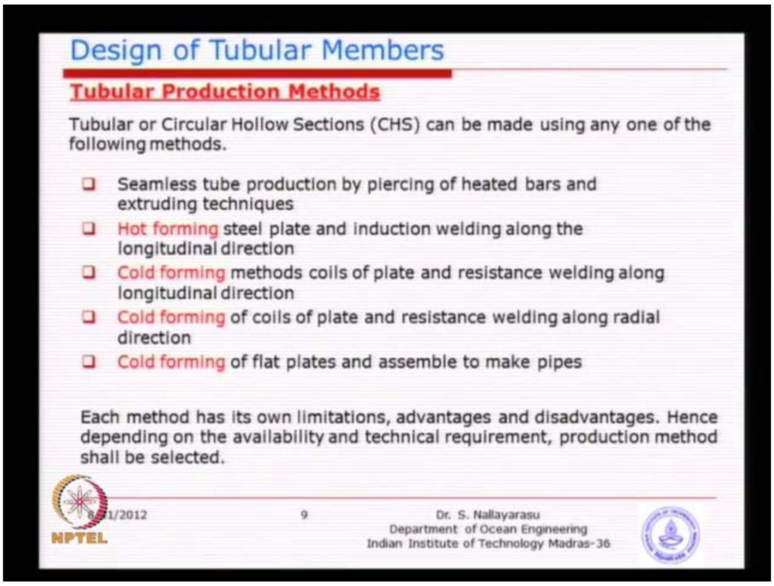

So, let us look at the tubular production methods there are few methods which normally used but, the most common. One is basically the cold forming using flat plates you know and because that is quite simple not involving any machinery of course we will also look at other forms. The first one is the very interesting one the pipes are made out of solid steel using pilgering and piercing. So, that is called seamless that means no welding is involved you take a big piece of metal and then just pierce through to get, but that is not a single process is a several processes of pilgering and piercing.

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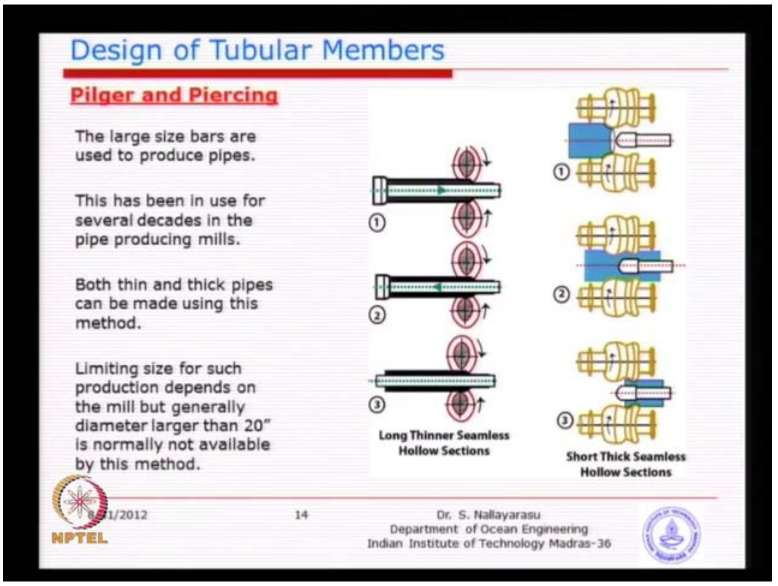

Something like this, so you take a several passes through and ultimately you may get a required thicknesses required diameter. Now, imagine if I want one meter diameter the solid piece of metal required is so large it is not very good idea that is why these so called seamless pipes are not easy to get when the diameter becomes bigger and bigger and bigger. But, to get a twenty mm diameter plumbing pipe is easy because easy to make such type of pipes twenty inches may be we have to think about it.

So, some of the mills they do produce as much as 20 inch pipes is nothing but, nearly half a meter diameter to produce that pipes you have to order upfront not at the last moment, so you may if you need a steel next year you should tell them this year. So, that they can prepare the mill and get the steel ready, so that so called seamless is no welding is involved pipe is supplied from mills and all other four methods. We have is there are hot forming or cold forming hot forming is basically the plate is heated I think if you have gone to blacksmith shop easy to change the shapes if you hit the material.

So, basically we try to heat it and then bend it according to the dimensions that we require and then do a welding so that is called hot forming steel plate with induction welding. Now, the problem is looks good the main idea is the heating requirement will be potentially high because the plates are very big. So, you need to make a is not going to be a small oven is going to be a big oven expensive and what we are trying to achieve probably three percent residual stress.

So, what the alternative is less reduction in the yield strength by three percent because we could save large amount of time and money. So, basically most of the time we do a cold forming that means do not heat it we still bend it and respect the dimensional tolerances respect the dimensions limitation like D by t ratio do not keep it too big keep it to the limits that we can do. Most all 3 methods will be using cold forming, so let us look at some of the pictures before we go to the steel manufacturing.

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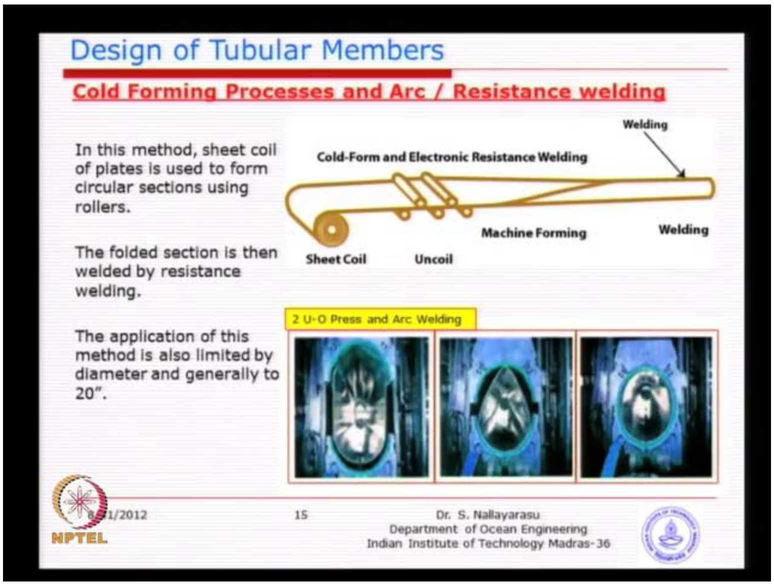

For example, we look at this methodology many times we have a coils of sheets coming from the mills, so just try and roll it and fold it do a induction welding a resistance welding. There are several forms of welding which I think you may learn in the next semester not in this semester I do not want to spend too much of time. Now, various forms of you know the methodology of welding depending on the instruments and equipments used methodology adopted. So, basically you can see here the roller is making the coils of plate to flat and then you just fold it and do a welding continuously. So, you will have a longer piece of pipes again these types of pipes are not feasible to be made for larger diameters because of this handling.

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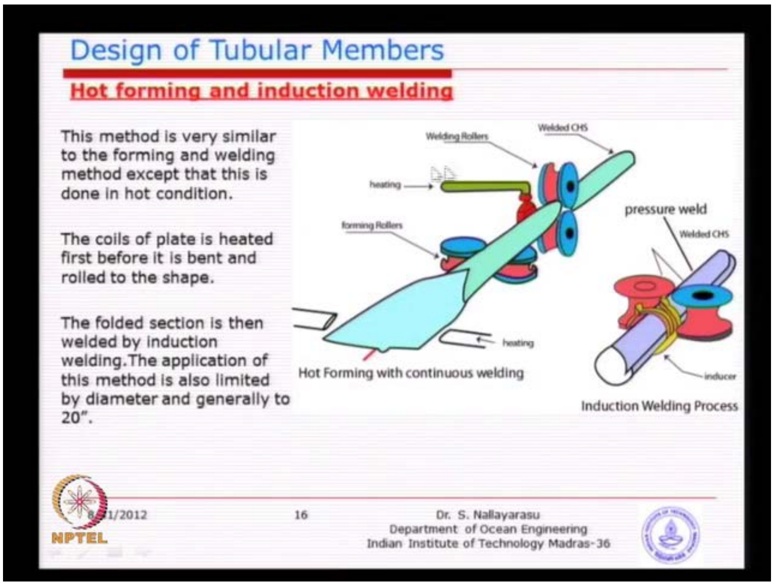

This method is very similar except that the method is using the induction welding instead of arc welding or the resistance welding similar rollers and passes fold it. You may have single fold or double fold also limited by 20 inch diameter or may be 24 inch some of the places they supply 24 inch.

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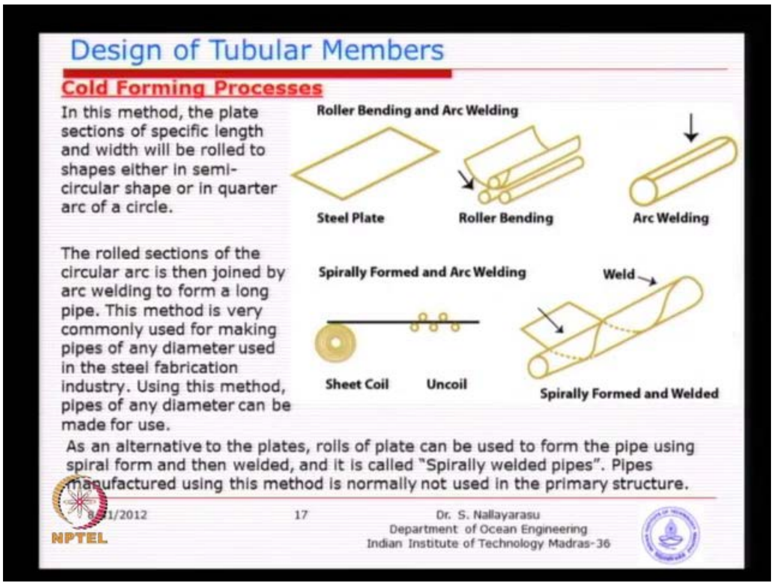

This method basically the roller bending and arc welding is very common in and you can find everybody has got this method of you bring the steel plates fold it by means of several sets of rollers and then do arc welding or you have a coils of plates. You roll it like a spiral I think you can try using a piece of paper you can do a spiral if you have a long piece of paper and then do the spiral welding. This is normally not preferred for offshore applications because the imperfections are more basically then the amount of welding is more number 1 and also the possibility of imperfections is higher, so normally not preferred, here you can make any diameter not a big deal of restrictions.

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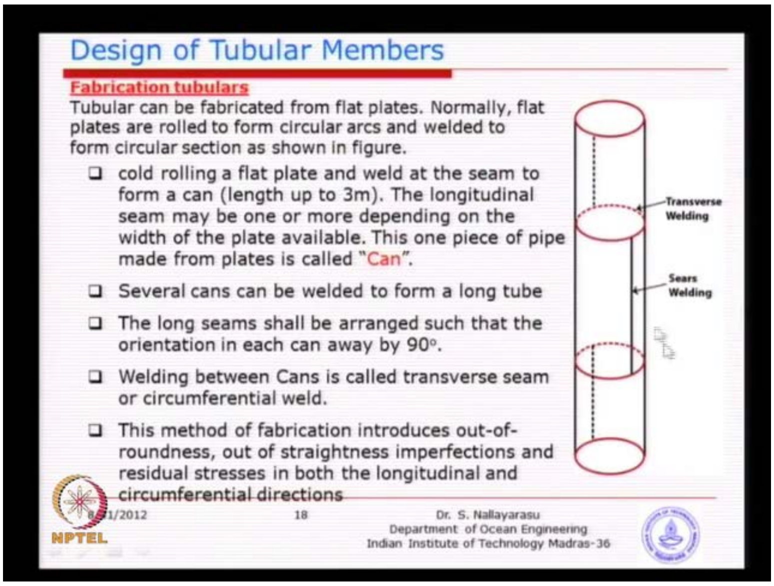

The last one very commonly used is assembly of whatever you have done here for example this bent steel plates have certain limits to make a longer piece of pipe you basically assemble several of them stat them together. The reason why I wanted to show is for example if you go back to this picture we got one line of welding along the top. Now, when you take few pieces of them you should not assemble in such a way that the line of longitudinal welding should match is very simple I think most those who have you studied civil engineering in the brick line construction you keep the fall clients in a different angle.

So, basically, but then you may actually do not think that there will be only one welding normally not feasible you may have more than one because you are not making the whole pipe using single plate folding. You may actually have two pieces you may have actually four pieces, so you will see that this top one may have four lines of welding two lines of welding.

So, making arrangement will become quite tough because we normally look for 90 degree deviation from one welding to other welding and you can only have at any one time 4 numbers of weld. So, this tubular fabrication is basically a simple idea take the plate fold it weld assemble one by one that technical name is basically the transverse welding and longitudinal welding sometime we called it seam welding or it is just a is called a seam welding seam, I think we can stop.