Elements of Ocean Engineering

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Lecture - 46
Tension Leg Platform

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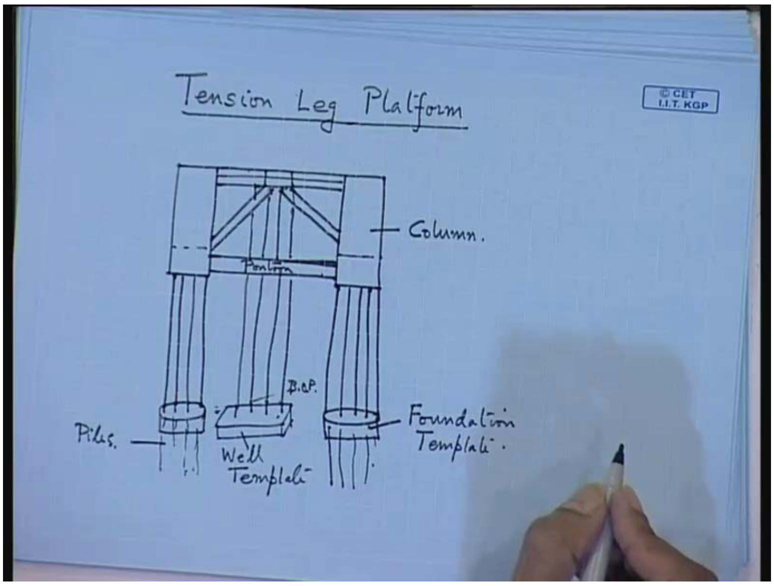

So, we will continue with the discussion to the tension with platform. Now, there is certain distinguishes about this which are different from your semi submersible, whether point of departure is in the tension in the cables. So, this is your pile foundation. So, this is called foundation template. So, these are actually pile then you can have your the riser from your so this is called a well template. Now, normally you will find the work prevents as stack at the bottom, but in some cases you may find at the top. So, behave is stand in normally you find case of plotting platform it is position at the well.

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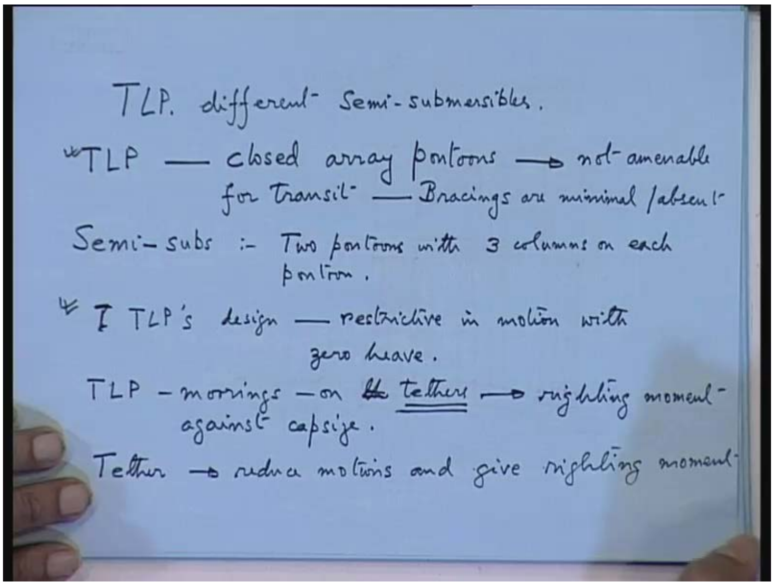

And now here you find there is to discussed is templates and TLP’s different from semi submersible; now the structure is also slightly different; now TLP’s structure you will find mostly closed array pontoons. Now, this type of structure is not amenable for transit. So, this is your one major your viewpoint of difference as a point is in variably in semi submersible the configuration that are given you just have a look semi submersible is fine. Normally, there is 2 pontoons with 3 columns on each one. So, this is the normal configuration.

So, this is here the present scenario. Now, here actually TLP bracings or minimum the underwater this structure that is to be designed bracings are minimum in sometimes absentness are totally absent. So, this type of structure is more suitable for TLP’s sorry TLP’s design; that is should be more motion find the restrictive in motion. What you with heave with 0? Heave for this is where you go for a TLP’s.

Now, if you find that you can do it some heave. Then it is bear to go from semi submersible. So, in our this moving TLP’s moving are essentially on tethers. So, tether is actually the main moving connection with the seabed it is? Now, tether also give what you provide the righting movements against capsize. So, this is the main function of the tethers; one is to this tether function you provide righting movement and also reduced the motions. Now, here the tether arrangement is of primary important; how you arrange the tether? The based on your tether arrangement the other configuration is…

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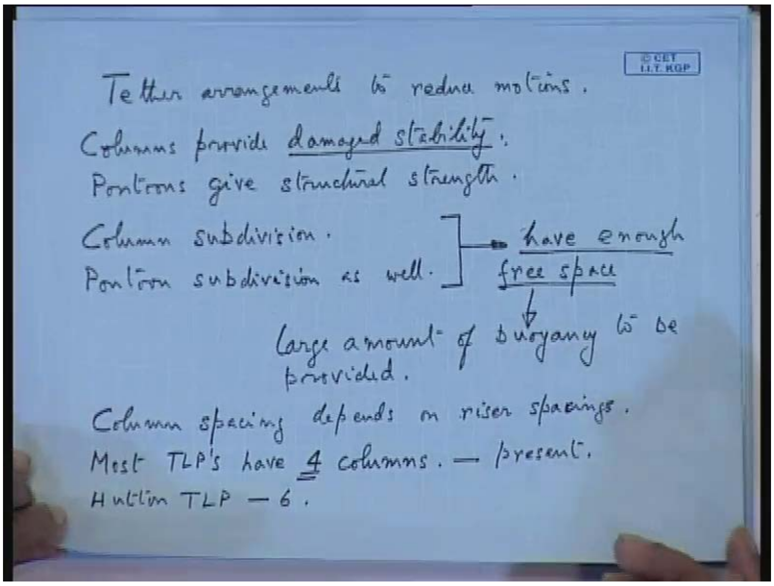

So, tether had arrangement you have to do to reduce the motion. So, this is normally done using main advantage of tether. Now, here now lot of configurations the common they want their drawn it is you are close direction to.

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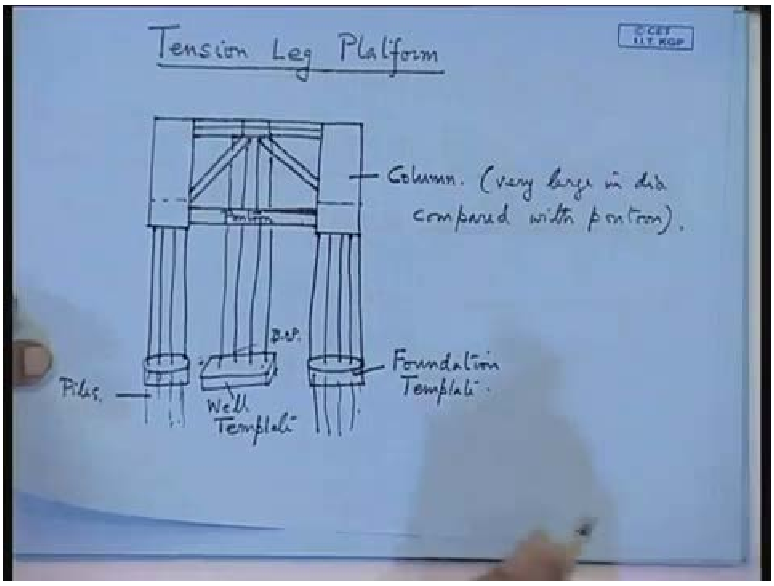

So, here actually pontoons will be on the all the 4 side here. So, these are your braces you can do I with braces, but one thing you should know that columns are in very large in diameter compared with pontoons. So, that means the major part of this stability is coming from the columns.

So, columns are give your damaged stability; columns provide damaged stability. So, whenever in thinking about the stability then your pontoons are essentially pontoons gives structural strength. So, your major strength remember this is a pontoons and the damaged stability is coming from the columns. So, subdivision you have to subdivide columns; column subdivision is important. Now, obviously, pontoons also be a subdivided. So, there is should be pontoons subdivision as well.

So, now these 2 have enough free space. Now, why this is come? You will find in TLP you have a lot of free space lavenders space, because large amount of buoyancy to be provide. So, basically you have to have enough buoyancy is to support here tended tension and the weight of the platform and your payroll etcetera. So, all this things you have to sufficient free space. And also riser configuration; column spacing depends on riser spacings. So, this is you have to configured. So, next coming to the decks now columns actually most TLP is have 4 column .Hutton TLP there was in 1984 Hutton TLP at 6, but in the present Scenario you find 4 columns this is your present. So, present structural configuration is less. So, in your columns actually you will provide damaged stability; and what else that providing?

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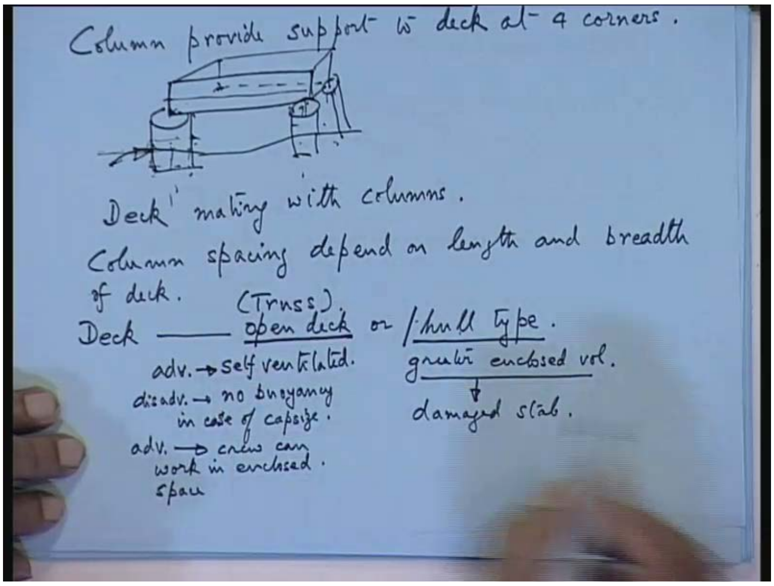

Columns provide support to deck at 4 columns. So, known when we designed the deck. So, you will find that it rise that they has to rise from 4 points. So, this is your deck. So, it will be resting on your columns pontoons. So, another column on so these are your columns actually provides supports you are deck and 4 points. And in between since your to have a with the transformers then the deck should have time to rigidity. Now, if you increase the columns spacing, your deck can also using the increase. So, that also you cannot go on increasing to the large extent.

So, here you have to deck as to make with columns for installation. So, this is one of the major points let you should remember; that columns spacing is to be decided on length and breadth of deck columns spacing. Now, coming to deck have to decide first you decide whether this is going to be open deck or this is have this called hull type deck like ship hulls. Now, this open deck as certain advantages; this is a disadvantages are advantages you write what is the major advantages? Self ventilated do not the bother about ventilation is very important for all platforms. So, if you have encamped gases which can in midnight.

So, those are actually given as if you have a open deck. Now, disadvantage is no buoyancy in case of capsize. So, that is another means major disadvantage. Now, another advantages is who can work in enclosed environment. Now, actually in TLP's your damaged stability calculation is very important, because of these reasons who can work in enclosed space. Now, if you have enclosed deck; so that means you have good mechanical ventilation in side, because you have to drive out inform able gases. The hull type is essentially the reverse of this.

Basically, they do, because of the greater enclosed volume. So, this is the major advantage this is coming, because of damaged stability. Now, remember that damaged stability the calculation in the case of TLP is very important, because at this region at your water line you will find lots of impact etcetera; where a impact large impact etcetera will comes this is a major reason; which has to be a lot of from accidental damage this is flooding zone. So, flooding zone is on the columns. So, deck coming to this. So, the deck is you decide whether you go for open deck hull type deck. Now, open deck is a truss; now these 2 types deck is normally you will find, sometimes the deck is fabricated in a separate shipyard together.

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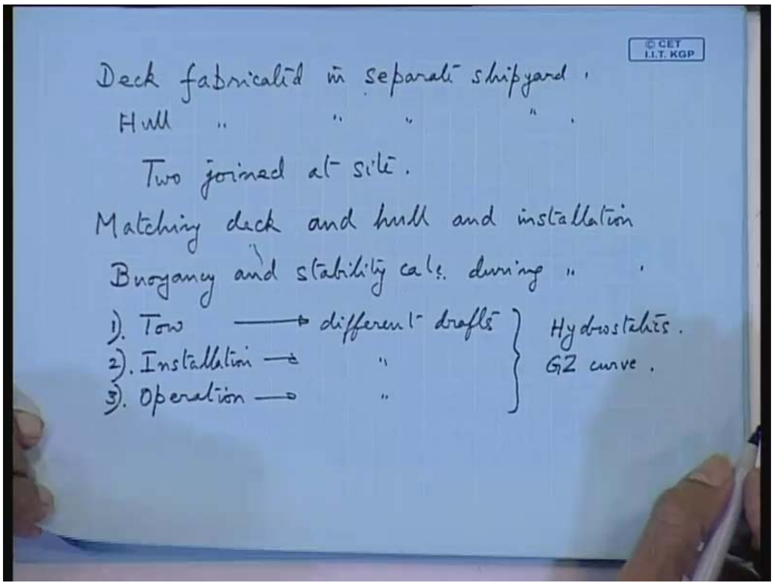

And, hull is also fabricated in a separate places. And 2 joined at site, because you see the deck design you will depend on your. The process facility be oil processing facility to the driving whatever equipments you have all of the things. So, deck normally fabricated in a separate shipyard. And all this fabricated in a separate here. Now, here the problem comes in matching deck and hull. So, this is the major problem and installation. So, this is the major problem. So, you have to do here buoyancy and stability calculations to be done driving installation. So, there is in a for developing the job, first you have to do all these buoyancy instability conditions during what during tow them during the installation. And the lost one is the operation phrase; these are actually different drafts.

Now, you have to calculate these drafts during tow installation than the operation involved it is during regarding us. So, drafts are different you have to provide here hydrostatic GZ curve. So, this is you are the buoyancy instability part is over. The next coming the other part that is the TLP is the and dynamic look. So, first you do your preliminary design; this have already talked I thing the last class.

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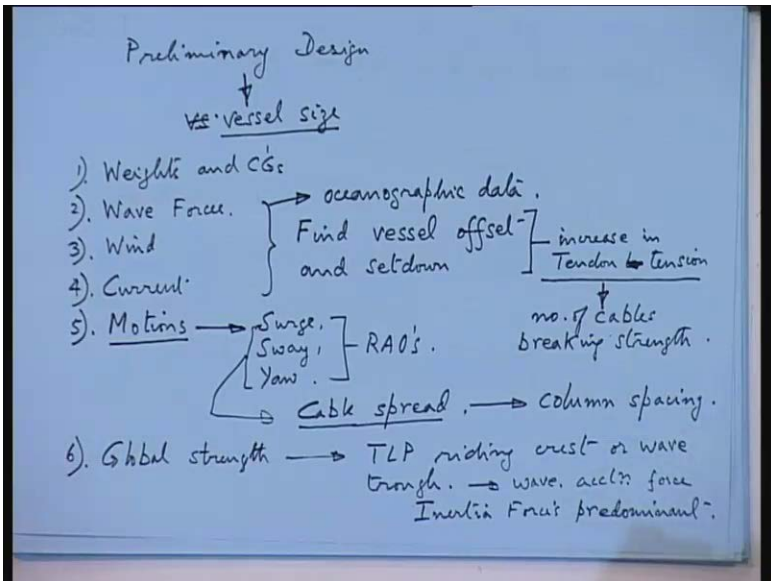

Here, preliminary design. So, what is your main objective in preliminary design we here you fix up they vessels size. So, that is your main depth graph all this parameters are to be fixed up here. So, here you have to do a lot of heat relations family with your hydrostatic stability, because that is the major factor. And the items that I told you is; weights and CGS. So, these are constantly changed in hard to have favor about hydrostatics damaged stability and letter on you find motions.

So, these are to be calculated; and in the next you calculate wave forces. Then wind; then current. Now, from these 3 forces you find there is a vessel offset and set down. So, these are these are all very important. So, this actually you find this leads to increasing tendon tension. Now, how much you can accommodate the increase depends on your tendon configuration. So, basically you have to decide the strength of cables number of cables and breaking strength.

So, these are to decided. So, tendon tension is very important in case of TLP's. Now, after this all this calculations that is why the calculation of wave wind and current forces very important. So, now, this you gather from oceanographic data, and then you calculate motions. So, motions in your always restricted heave. So, heaves come under based tendon tension. Now, what about this motion? Surge, Sway, Yaw. So, these you have to find out from RAO's are basically you transfer function. So, you have to do a lot of now you will find that this is also related to you are all these are related to cable spread cable is cable spread.

So, this is another important parameters; which decides on columns spacing. There remember your TLP's basically centered around is motion characteristics. The buoyancy and stability not that important are, but this motions have to be minimize. The last one is global strength. Now, here actually the strength is not have the ship strength. Now, here you have to find out from TLP riding crest or trough. So, here you calculate wave mainly here accelerations wave acceleration force. So, mostly you find that inertia force is predominant. This is the sort of structure of these have to be calculated. So, you find lot out at time calculation you have to do recite structural configuration. So, that incentive designs; now coming to the hydrodynamics. So, you find the various configurations of your team the that one have drawn.

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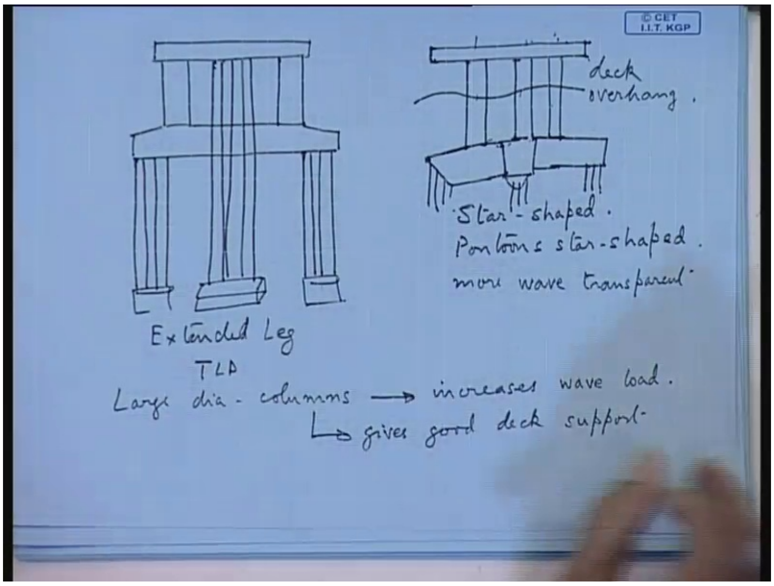

Now, you can extend your TLP the pontoons. So, pontoons can configuration can also be like this. So, these are called extend like TLP's. Now, basic reason I told you the, because you want to have a spread on the tether you increase the tendons spread. Now, later on you find if you increase and spread than you can reduce the pitch motions and also your basal of sect. So, this is called your extend like tether the other form you can also have these all are having this one tendons column. If you want to have a smaller TLP then you can support the deck. Now, I told you the previous one that I have talked about you find the deck is resting on 4 columns, but here you can see that the deck is having the substantial over hang.

Now, here at the middle you can have say this is a these are the columns. And each column you can protrude the pontoons I cannot draw the shape properly. So, this is your star shaped platform; your pontoons in this contribution it will come this is called a star shaped. Now, here you can see that all this columns are more or less not very much distance apart the giving support to the deck. Now, here you find the deck as large over hang pontoons star shaped. So, why you are going for this type of complicated shape when you can do the simple shape? Now, at the end of these pontoons you can attach your terrors.

So, this is another element. So, you designed actually you will have to figure round at I will tell you first is you decide on this type of either this type on this type based on your rises spacing; you cannot regulate your riser dispersions. So, this type of closed column if you are riser spacing allowed go for that. So, this is another type. So, this is called a star shaped dining table. Now, basic thing is he has done here you can see the columns are much more slender than this type of 4 column arrangement.

So, here video city wave load some main design will be centered around. Now, you see larger diameter columns; they have the inerrant weakness that is increases wave load. That is your diffraction load is going to increase. I suppose, you studied wave reflection diffraction around this. Now, here also, but large diameter columns gives good decks about. Now, you have to optimize between this 2. Now, you can see here the deck is hanging an overhang and between here number of columns slender columns.

So, this is more wave transparent, wave loading is another from the hydrodynamic calculation you find lot of calculations you to do it. You calculate the drag forces that have come from to the hall by there are second order of forces, first order of forces. Then I have told you about wave run-up and all those things. So, the TLP motions are actually governed by the wave mechanics. So, this part you have to decide either whether you are going for this type of whereas, in front of this type of arrangement or this type of arrangement. Now, you can see the reduction in the pitch off set you have done by increasing the tether spacing and you have not increased the column spacing column space you have limited. Now, here actually if you the tether spacing attached to the end columns. Then if you increase the columns spacing there; obviously, your tether spacing reward will increase. So, that is one of the major drawbacks and next you have to think about.

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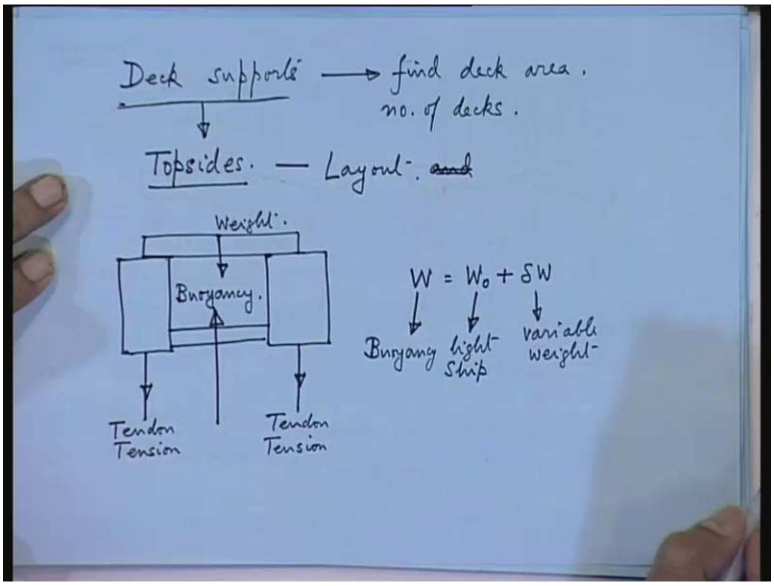

Now, the sort of deck you have to first you think about deck supports in all the 2 elements. Now, find deck area. And if we cannot accommodate all to the equipments then you go for number of decks. So, here actually this deck is called and if you go offshore there are called top sides. So, that is why the top sides are actually fabricated in different superior altogether. So, topside layout and number topside rather simply say topside layout. So, topside layout is very important in case of TLP rather in case of semisubmersible thing in any offshore activity or offshore platform; you go first thing you told you to design topside. So, here actually this major point is coming, because of support to your deck.

Now, coming to the mechanic spot you will find that your; let us say the common TLP that we are having so the deck is resting on saying the columns corner columns. So, this is the most relevant design very easy. The other type of design you have to the nonconventional design and there for a particular environment. So, here you draw free body diagram. Now, the wait will be acting somewhere a let us support the weight is coming from downwards. And the major points forces coming somewhere here followed. Now, next your tether tension is going acting downwards. So, this is tendon tension. So, what we find is that total wined sea is equal to this is your weight plus delta W. So, dealt W is your variable weight and this W naught they call light ship. This is your total weight and this W is your buoyancy. So, your buoyancy has to support what is the buoyancy equation?

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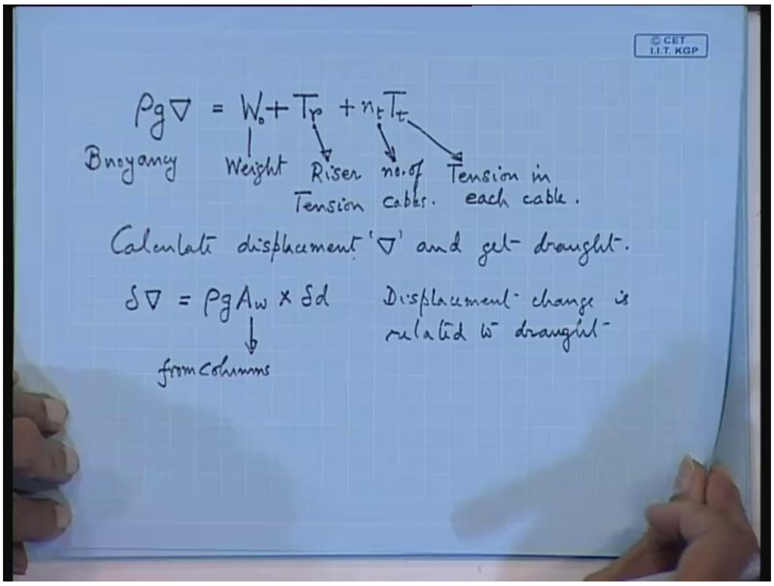

Rho g. So, that is going to support what? Your weight times you call ship light plus what is T r? So, that is the now this actually you can called W naught. So, this is your buoyancy, this is your weight, T r is what? T r is riser tension. Actually, here TLP has to support both your cable tension and riser tension and riser is also kept under tension similar to you cables. So, n t is number of cables. And this is tension in each cable. So, this is your basic equation. The audio studied equation you have to follow it; from this you calculate displacement and get draught. So, this is your audio studied equation.

Now, any change in this displacement say delta W is equal to how much you are rho g water plain area multiplied by change in draught. So, change in displacement is equal to water plain area into change in draught. So, displacement change, because this things water plain area you cannot change; this is given by columns from columns. So, this is fixed and draught can be changed. So, displacement change is related to draught. Now, you see there is another parameter which is called set down. So, this is your TLP in vertical mode is a normal mode.

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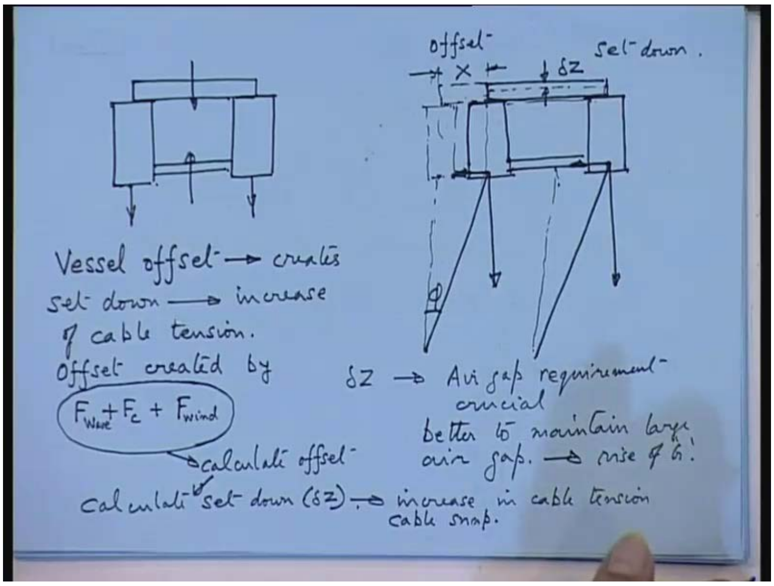

Now, suppose it is tracked our weight and there is a set down; what will happen? Say this is your TLP when there is no wave force. So, everything is your weight is coming down buoyancy is going up tether tension is this is your free body diagram. Now, the TLP is displaced. So, there is a offset. Now, as a result of this off set model has been there is the set down. So, you calculate vessel set down. So, this is your new configuration; your original position was somewhere here.

Now, what has happened here is? This is the direction of a horizontal force, but your cable is anchored to the seabed; see you get another downward force. Now, here also there will be the cable tension will come like this. Now, you find out how much is your offset calculates this angle find. So, you will find vessel offset created by. So, your offset is this is your offset or X offset X. Now, here no trend, but your deck will also be in this region will come down.

So, this is called a set down delta Z, X is called offset; your TLP set down is occurred. Now, this is what are the reason in TLP actually you go for a larger air gap rather than semisubmersible in TLP, because of this delta Z air gap is very crucial air gap requirement crucial. Because of set down; in semi submersible you do not have a set down semisubmersible will simply go in the search. Now, you can do that will be enough cables chain cables are there take care of the way. Here, you do not have so much of chain cable. So, the set down is going to happen.

So, air gap is better to maintain large air gap, but if you have large air gap there will be another problem rise of G. So, everywhere strike compromise between all these parameters. Now, this vessel offset you find this creates set down as a result of this what will happen? Increase of cable tension. Now, this is the another point in TLP that you come, because of your set down you are having increase of cable tension. Now, offset is created by summation of this sea forces; weight force plus current plus what force coming from wind wave and current.

So, from this actually these 3 forces calculate offset after you calculate offset, you calculate set down. This is your delta g or delta Z. And after this you calculate increasing cable tension. Now, this increasing cable tension should not be so high. That it leads to cable snap, because of offset you have a large offset then your cables cannot have accommodate that. So, it will snap. So, this is you will find in your the next equation have to calculate; what is the increase in the offset? So, changing displacement we have found out. Now, you find out the cable tension. So, attention in each cable is?

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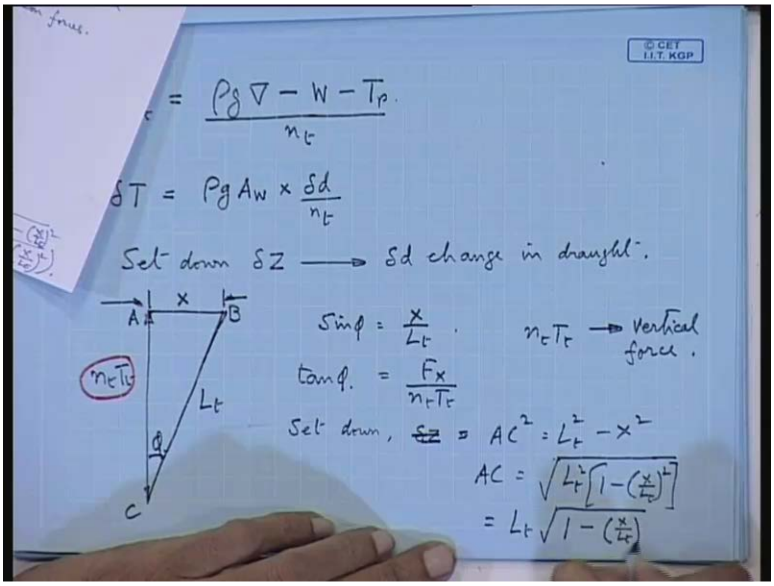

So, the tension that we have worked out is rho g delta minus; there are 2 forces minus weight and riser tension, is not it. So, this is cable tension and this is riser tension you simply divide this by number of cables. So, this is your equation. Now, in change in cable tension you write delta T. So, what is your delta T? This you can find out it is this is your water plan area delta d is to change in draught n t is the number of cables followed. Now, you find out this. Now, if you calculate set down is actually your delta Z. So, delta Z is your delta d for change in draught.

So, now you calculate this say this is your now you calculate the angle 5. So, you lent of cable will remain the same L t. Now, offset is x followed this angle is 5. Now, from this diagram can you calculate set down. So, sin phi is how much? X over L by t. Now, if you take the now this tan phi is equal to F X over n t T t. Now, this n t T t you remember this is always are vertical force this entity in this direction; how was your displacement should not mix up this? Because in our buoyancy equation.

So, we have entity contracting your weight and buoyancy all these are normal. So, from this we can get this tan phi. Now, set down is a much you just look at this diagram; set down is given by delta Z. So, this arm is do not mix up with this force equation; you just calculate the length. So, how much is that length? This length is how much see first you calculate this A, B, C; we followed our delta Z. So, AC square is equal to L t square minus X square followed. So, AC is equal to how much you write like this you bring that L t out. So, this is L t square into one minus X over L t this is square is it right. So, this is your L t into route over 1 minus X over L t square. So, now what is your set down?

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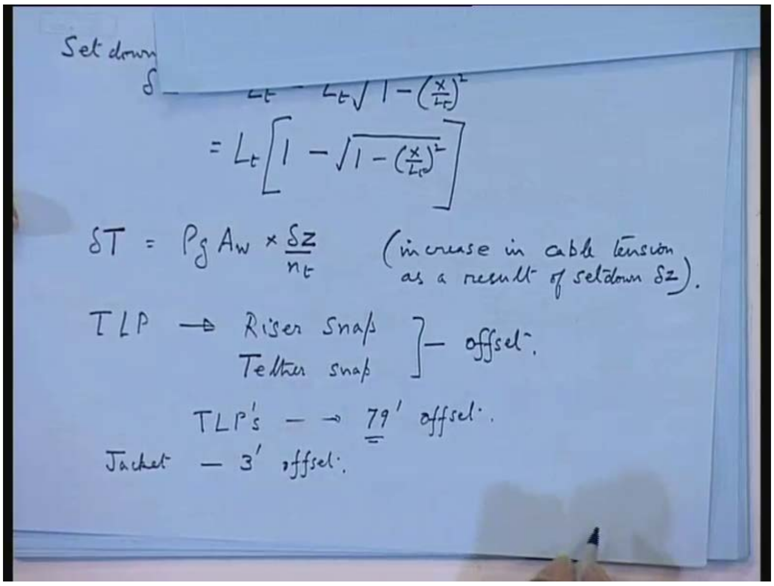

So, set down delta Z this would be L t minus L t into route over 1 minus X over L t square. So, this if you signify this comes to L t into this 1 minus. So, this is your set down followed. Now, the set down will transport into increasing tension. So, delta T you find out delta Z from this will be rho g A W multiplied by delta Z divided by n t. So, this is your increase in cable tension has a result of set down delta Z. So, this actually is very important delta T. So, this should not increase to such an extent that it goes behind the breaking stent to the cable; how as you can payout? If this increase in the tension stress tansies will keep on paying out the cable, but if you payout these cable increase the length of the cable. Now, what will happen to the riser? Your riser is going to increase the length of the riser also.

Now, that also is very risky, after a certain increase you cannot the riser the riser cannot accommodate that increasing the length of the riser. Now, you are riser snap lock. So, TLP actually you have to be very careful about these 2 aspects; one is riser snap and tether snap. So, these 2 things will occur, because of offset TLP offset. So, TLP offset is normally you have to limit this. Now, the presented TLP scan accommodate TLP have been fabricated to accommodate that as much as say 79 of offset 79 feet is no joke; whereas, in your jacket platform jacket can also only give say 3 feet offset. So, remember go on board at TLP 79 feet going this way that way. So, the next day you say you pray to god you will get out of that here anyway. So, in that will continue our discussion.