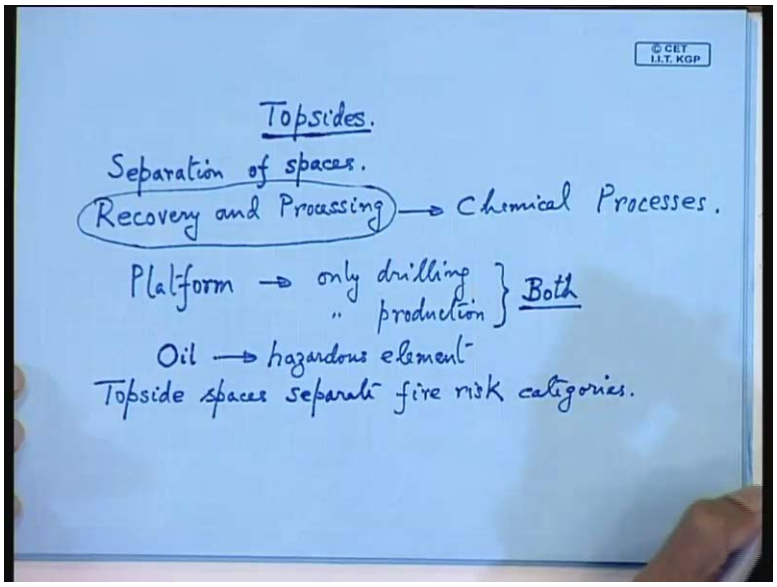
Elements of Ocean Engineering
Prof. Ashoke Bhar
Department of Ocean Engineering and Naval Architecture
Indian Institute of Technology, Kharagpur

Lecture - 25
Topsides

So, today's lecture will be on topsides, after that I will talk about mooring systems, let us finish with the topsides.

(Refer Slide Time: 01:03)



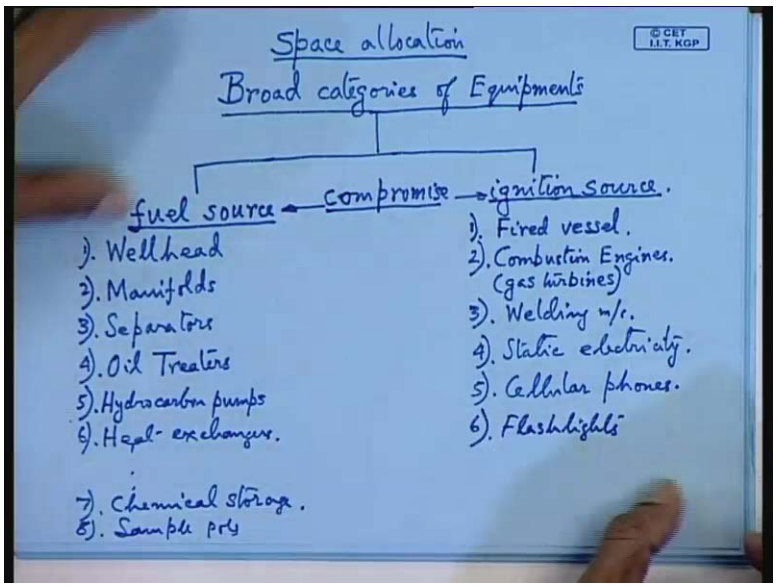
So, I have told you about the layout considerations. Now there are certain other considerations that you have to follow. Now this is your shift j. Now here actually there are some special considerations, because this is an offshore platform. So, the segregation of those spaces I have told you I have given you an idea. Now there are two major points that are to be remembered is separation of spaces vertically and horizontally. So, the main works of these types of structures are recovery of oil, so recovery and processing of oil. So, their associated equipment should be geared to this recovery and processing of oil. So, actually all this if you want to understand then this is actually related to your all major portion would be related to your chemicals systems.

Now some of the terms that you will come across here will not be familiar with because you are more familiar with your shifts j. So, most of these systems that you will come across are related to chemical engineering which is processing your crude oil or cracking

of crude oil. So, there are two distinct types of I told you operations. So, these are actually chemical processors. So, last class I told you whether you have platform what purpose this is going to serve, whether you are designing this for only drilling or only production or a combination of both. So, your topside facilities have to be gated to this type of demand.

So, most of the platform nowadays you will find that they are capable both for drilling as well as simultaneous drilling and production. So, that means you have to arrange all your topsides facilities according to the drilling and production modes. Now the other point that is to be remembered is this is oil is you are playing with oil. So, this is a hazardous sort of hazardous elements likely to catch fire. So, that means your topside layout you have to separate spaces, topsides spaces; first thing that you decide is separate fire risk categories of spaces. So, I will tell you what are these risks. So, you have to separate all these spaces because there are possible on board and it should not catch fire.

(Refer Slide Time: 04:54)



Now the broad equipments that you finalize it is a broad categories of equipment that you have to class according to the, and the spaces are going to be earmarked according to these broad categories of equipment. So, these are some of the new things that you will be learning while you are designing an offshore platform. So, what are these broad categories? Now broad categories you segregate equipments into two broad categories. So, the first one is you write fuel source and the other one you write as ignition source.

So, now remember these all your topside layouts are going to be inspected by your survivors.

So, that means you have to satisfy these survivor requirements, and it may not be possible to segregate completely fuel source with ignition source because of the constraint of space requirement. So, you have to strike a compromise between these two somewhere. Now there is a tradeoff actually. So, you are trading that is risk of fire is where. So, that is one of the most disastrous consequences. So, you have to strike a compromise between these two. So, all these factors are will come into your general layout that is your topside facilities.

So, compromise between these two equipments that is fuel source and ignition source as far as space allocation is concerned. You have to allocate spaces for visible; now how you are going to allocate? Now after allocating the spaces what you are going to do? So, those are in general some of these fuel source I will give you; fuel source you find primary fuel sources is your well head that is from where the oil comes out. Then of course, you have a long list.

Then you have manifolds; manifolds are branches from where the piping's are taken. Then you have separators. So, I am not giving you all the equipments which is some of the list. So, oil treaters. So, basically you can see that these are all chemical engineering terms; however, as a naval architect or also an engineer you have to know some of these. So, hydrocarbon pumps; hydrocarbon is your oil.

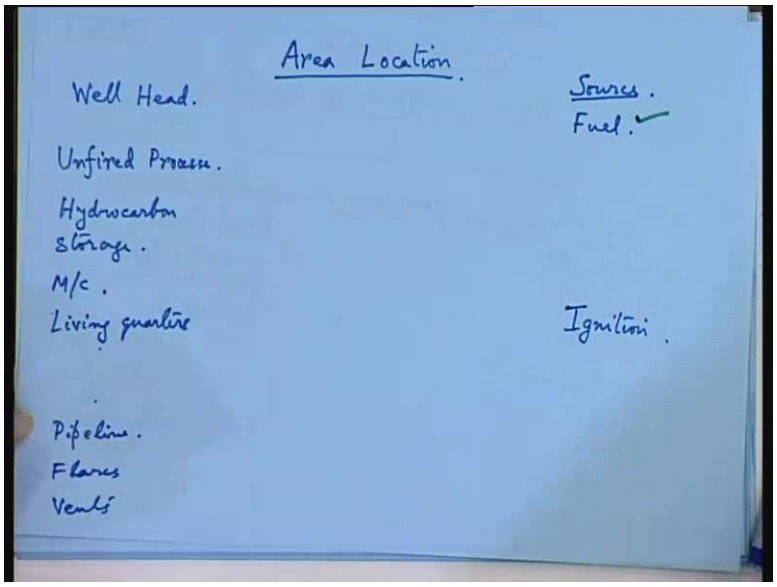
Now all these actually come under the heading of fuels source that is the sources of fuel or sources of oil. Then you have other heat exchangers, etcetera, a long list. So, I do not have so much of time. So, you can take the notes. So, like this it goes on. Then you have last you have chemical storage and sample pots and under this ignition source; that means these are sources which that means it will catch fire; that means there should be what? Ignition source is a potential source of sparking or flash point. So, this first one is fired vessels.

So, what is a fired vessel? Fired vessel is something of your this boiler; boiler is a fired vessel, It can be a oil fired boiler, normally of course, it is a platform. So, you have oil fired boiler. So, oil fired boils is the potential source of fire; that means, you are having a fire over there, fire or a spark. Then you have combustion engines. So, these are maybe

your engines for driving various pumps, so combustion engines. So, this sometimes you may have for power you may have gas turbines. So, that means you are having ignited gas in this turbines. So, that is potential fire hazard. So, you have number three you may have welding machines.

So, like this you have static electricity. Static electricity is the potential source of fire; that means you are having sparking. Then you have cellular phones, flash lights, etcetera. So, that means if you go to a petrol pump they will say that switch off your cellular phone. So, similarly here also you see cellular phones are not to be used, say, flashlights. So, these are the equipments which causes spark or fire and these are the fuel lights; that means as such they are not burning, but since they are having oil in it, they will catch fire easily. So, now you have to separate these two categories of equipments; this is our first job.

(Refer Slide Time: 11:17)

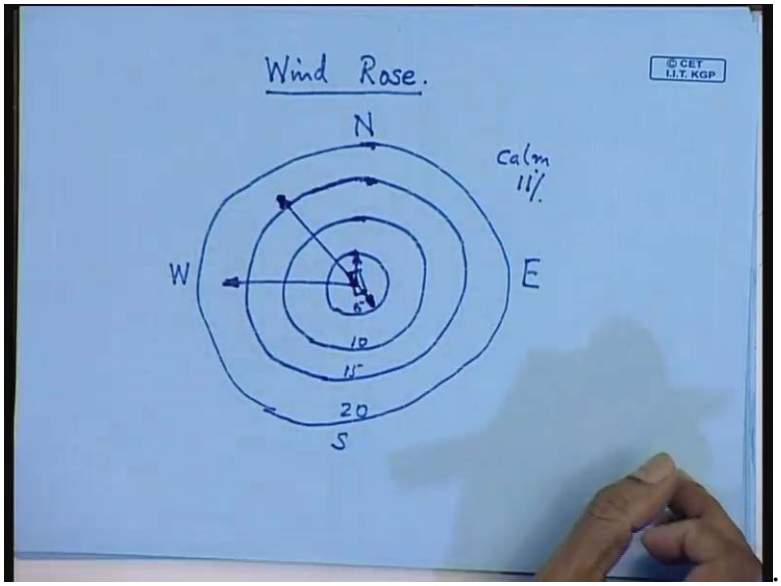


Now the other job is the areas where you are going to locate them. So, area location; first you segregate the equipments. Then you specify the areas where they are going to be located. Now areas are so one of the major areas is your well head. So, again you find out source type source, whether you write is a fuel or it is an ignition source fuel or what I said ignition. So, like this you segregate your areas.

So, well head is there. Then you have unfired processes. So, these are the area requirements, then hydrocarbons storage, then machinery quarters, etcetera, living

quarters. So, like this it will go on. Then this is pipeline, then you have flares and vents. So, these you allocate the areas for these operations, specific area requirements. So, like this we formulate your objective, but again you segregate on the basis of these two sources that is fuel or ignition sources. Now you remember this.

(Refer Slide Time: 13:26)

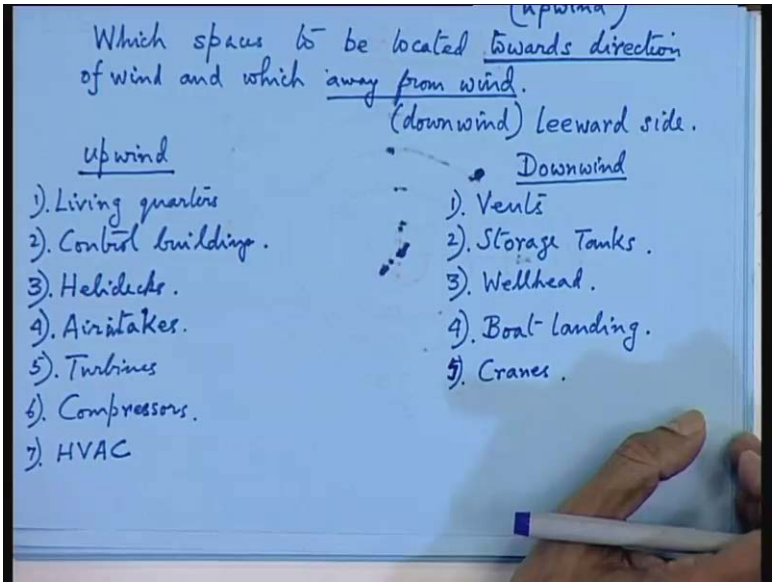


Now after this, what you do is you find out what is called a wind diagram. Now sometimes this is called a wind rose. So, this is another interesting study; for that specific environment you construct a wind rose. Now wind rose you find it is a number of circles, say, you come across this table circles. Now wind rose actually gives you the percentage of the year, wind is going at a particular direction. So, here you find that percentage of time. So, this is your 5 percent of time; this circle denotes 5 percent, next 10, then you have 15, say, like this it goes on. So, 20 percent of the time you like this you contract a wind rose.

Now after that you give the directions. So, the directions will be your north, east, south, west, and your platform orientation suppose is somewhere like this or you can take this a well head orientation. Now these directions will give you that is less than 5 percent of the time in a year your wind is blowing in this direction, the north direction. And if I draw a vector like this then this will indicate, say, this is more than 15 percent, say, around 16 or 17 percent of the time the wind is blowing in the westward direction.

And you have no wind, say; this is because wind rose for Gulf of Mexico say calm; that is no wind is for 11 percent of the time. So, like this there will be a number of directions you will get, but directions please remember that these do not signify your intensity. The vectors only give you the percentage of time the wind is blowing at a particular direction. Now after you have done this you try to look at your spaces.

(Refer Slide Time: 16:15)



Now the first thing that you do, which spaces to be located towards the direction of wind and which towards away from direction of wind, why? But this is a very important concept and I remind you. The first thing what you do is that you segregate the fuel source from the ignition source that is your first job. Now you find out which items you will be located towards the direction of the wind and which are those? Because of the reason, that means, suppose it catches fire there is a flame that is your position towards the direction of the wind. So, the adjacent space will be catching fire. So, these are to be some of these I have to tell you.

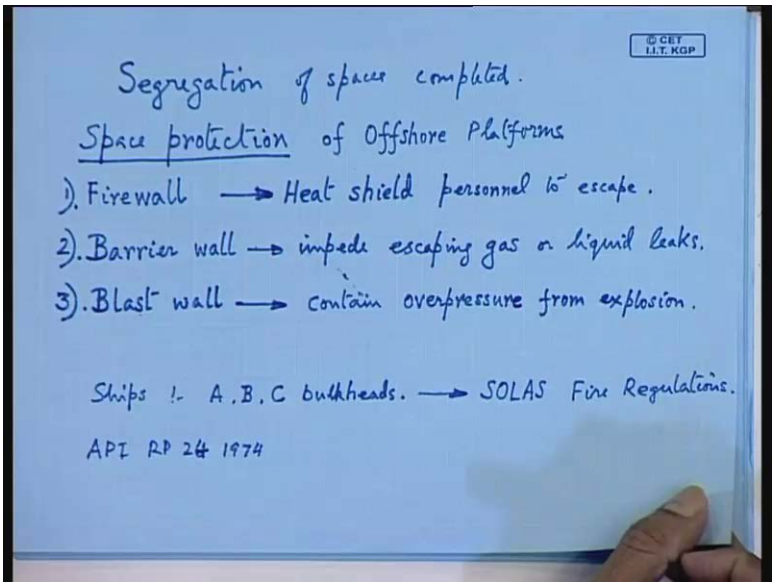
So, this is called towards the direction of wind is this thing is called upwind, and the other direction is called away from wind is called downwind, or sometimes this is called in the leeward side. So, when you happen to visit an offshore platform you can see this lecture you just get a glimpse of what is there in store if you visit a platform. So, downwind and leeward side, now upwind consideration, upwind the spaces are these;

that means these spaces will face the wind. So, these are living quarters. Now next you have control towers or control buildings.

Then you have the helidecks, air intakes; air intakes for your ventilation pumps, ventilation levers. So, those are air intakes. Then turbines, compressors, turbines, you have compressors; all these will be positioned upwind. Then number seven is HVAC, heating ventilation and air conditioning equipment. Now, on the downwind side, so that is these are going to be protected from the wind. Downwind side you give vents; that is the wind is blowing using this direction. The vents should be in the opposite direction; it does not play vents in this direction. So, these are some of the rules that are to be followed.

Downwind side you have vents, storage tanks, compressors whether it also will come here. I think compressors here also we can give wellhead, and the other is boat landing. So, that means in case of evacuation of the platform, the platform has caught fire. People should not be exposed to very high velocity winds. So, the boat landing you put on the downwind side, then cranes; sorry this is five, cranes. So, these are some of the equipments to be located in the downwind side. Now after this, so these are some of the segregation of spaces that are to be remembered.

(Refer Slide Time: 22:00)



Now after you have done the segregation of spaces next what you are going to do. So, this is your first job. Segregation of spaces first you do for the ignition and fuel

equipments, then upwind downwind. Now next after you have done this segregation of spaces is completed, after this you do the protection of the spaces. Now all these are geared for fire protection. Now space protection you do by three means, followed? First one is you erect what is called a firewall; I will explain what is a firewall. Number two you erect a barrier wall, and the third one is called a blast wall. In the event of explosion, that means you have to erect a blast wall.

So, firewalls actually basically they provide what is called a heat shield. Now this is similar to your ships j; whenever we are doing the general drawing of any ships, in ships you come across these three types of bulkheads. I do not know in your ship design you will come across the A, B, C bulkheads; these are similar to them. Instead of bulkheads they are calling firewall, but their construction is different from these simple bulkheads. Construction is different A, B, C bulkheads. So, all these things if you want to know you just look up what is called SOLAS fire regulations, regulations for the prevention of this spread up fire, SOLAS or IMO regulations. So, these are related to ships but on a much more stringent scale you will find for space protection of platforms, offshore platforms.

So, in ships if you come across these types of A, B, C bulkheads, in short I am telling you. A are the bulkheads which are made of steel, okay. Now b is other type of bulkhead maybe steel or it may be of aluminum. C is made of this plywood, plywood partitions primary plywood. So, anyways those when you do your ships here you come across this, but similar this thing you find; here actually it will come mostly steel.

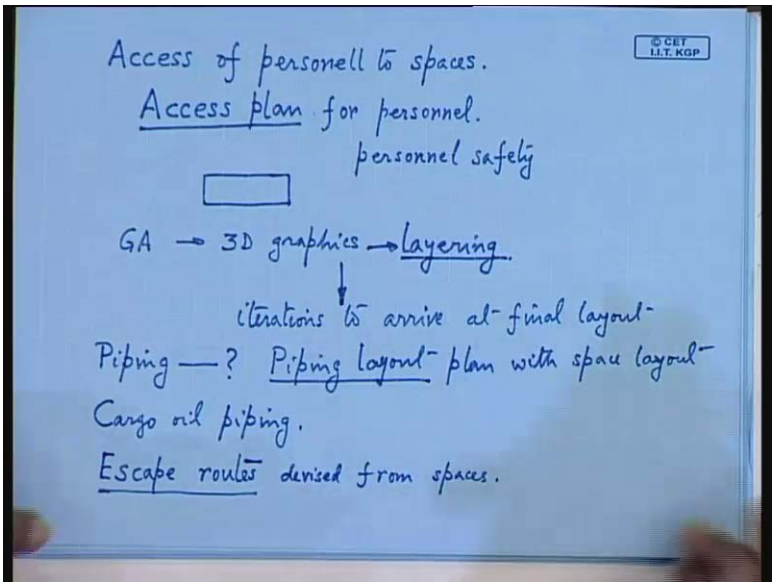
Now you have firewall is actually providing a heat shield, but it should also allow personnel to escape. Now actually the more detailed construction requirements you get in the API code, the code number is not given. I think APIRP 2 6 that gives you from the API code American Petroleum Institute. A p I report 2 G, this is 2 G 1974 well in detail about all these revolutions.

Now personnel to escape, now barrier wall their basic function is impede. Firewalls basically it will produce a heat shield from personnel to escape. Now barrier wall impedes escaping gas. So, basically this is a gas tight compartment or escaping on liquid leaks. So, this is a barrier wall. So, actually when you design a firewall it is different from a barrier wall, okay. And last is the last one is blast wall. Blast wall actually from the very term that is blast you will find that it should contain overpressure. So, whenever

you come across the word blast; that means, there is a sudden buildup of pressure from gases.

So, these are blast wall has to be designed in such a way that is to be specifically strong to contain overpressure; so over pressure from explosion. So, after you have segregated the spaces, so you give protection to the spaces by either of firewall, barrier wall or blast wall. So, remember this in your topside GA plan. So, after this there are various equipments. Now the other point that you should remember is that you have to plan.

(Refer Slide Time: 28:49)



So, in general has been drawing or topside layout that you are doing first you segregate the spaces, then you have to connect the spaces or access to all these spaces, access of personnel to spaces. This is also similar to your ship General Arrangement drawing. So, after you allocate the spaces all the spaces have to be connected or serviced. So, remember that that you should provide, suppose in your engine room or in your machinery room you have some machinery. Now actually I have seen mostly they do not provide enough space for people to service the machinery in the ships main engine. You do not have enough space; that is you cannot walk around the engine or you cannot lift out the components.

So, access plan, you have to draw what is called an approved access plan. This is very important, because after this for the platform to become functional you have to have a schedule access plan. An access plan is quite tricky from first y because your platform is

quite a large structure; that means you have the deck and suppose this is a gravity platform, and you have to go down below into the water. So, the personnel will experience lot of dangers from high pressure and all this fire high pressure and all these things will come.

So, access plan for personnel is top priority to all the spaces. Now how will you design an access plan? So, first of all the personnel who is going to these particular spaces he should feel protected, is it not? He should not expose him to first thing that you should show out an offshore structure; you should not expose personnel to what is call bad weather or suddenly he is thrown overborne. So, risk of personnel safety is there. So, this is your primary consideration. So, personnel safety, assets plan, assets to all this spaces that you have to provide, and remember one thing as soon as your providing an assets plan your are also providing a path for the spread of fire.

So, that means the two. So, you have to strike a compromise between all these things. So, nowadays what they do on your General Arrangement drawing that is your topside facilities you do in 3 D AutoCAD or 3 D graphics. So, this is normally joined in the shipyard in your design office that you have to prepare you General Arrangement drawing in 3 D. So, 3 D graphics I think most of you have done in solid works you used to draw an AutoCAD. So, you have to be quite proficient in that and 3 D graphics you to do number of layers. So, that is called layering of the drawing. So, nowadays everything has been computerized. So, you have to be quite proficient in this now here actually.

So, after you locate all those spaces, access plan all this, the reason is that you have to do number of iterations to arrive at the final GA, to arrive at final stage at final layout. So, because the items will continuously change, so we have to interface with the other engineers. So, your main thing that will come as an obstruction is piping. Your piping is very important in offshore platforms. First is location of all the equipment I have told you. Now all these equations that is your well head, compressors, etcetera, and other machineries, they always have associated piping; they are not independent or stand alone machines you know.

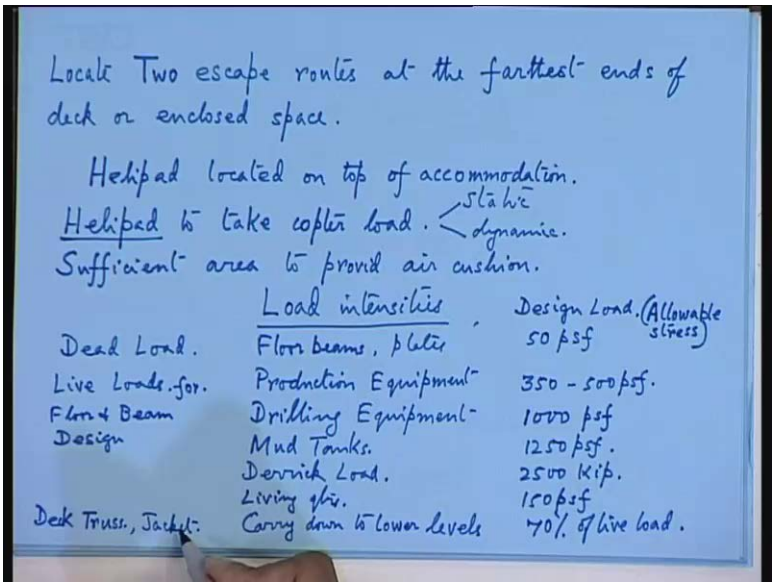
So, piping is very important, and how will you design these piping? So, this in your platforms you have specialized piping engineers who do the piping layout.

So, piping layout continuously clashes with your space layout. So, piping space layout always is associated with a piping layout plan, then plan with space layout. Here you can see that constructing a GA. Now drawing a GA is not a very easy task. First is segregation of spaces, then you draw the access plan, you connect all the spaces by access, and then all these equipments and other they have their associated piping. So, then again you have to do a piping layout.

So, all these three will be either clashing with each other or they have to harmonize, they have to be linked. So, this thing is a major task and piping of course, I am not going into detail of this. Now piping is very important. You have first is the internal piping and then for all these platforms you have what is called cargo oil piping, cargo oil or sometimes these are called oil piping. So, these are actually different from your internal piping. So, as graduates I think some of you should have some idea of these piping arrangements. So, I think after the moving if I have time or I think in your next offshore technology I will talk about this piping in moving space, anyway.

So, this access plan that I have talked about. So, this is to be remembered and after you have designed the personnel safety. So, this is providing access to all your compartments, and now after your access then you could device what is called escape routes. Now remember, that means, your personnel they are working in a platform which can either explode or it can catch fire easily if your due to negligence or due to say blowout, etcetera, it can happen. So, that means you have to have escape from all these spaces, escape routes devised from spaces. Now escape route when you design that the most important point that you should remember is that to escape.

(Refer Slide Time: 36:43)



Now this is also similar to ships; when you will be doing your ships GA you should never have two escape roots very close to each other. You should locate two escape roots at the farthest ends of deck or enclosed space. For the simple reason that if one of the spaces catch fire then the personnel can immediately run to another space and he can save his life. So, that means the two escape roots should be designed at the farthest ends of the enclose space or deck, whatever it is. So, here these are the measured points that you remember. The other point that is the quarter's utility buildings; of course, I have told you that you segregate and you erect a firewall, and normally you have the helipad.

Helipad is usually located on top of accommodation. Now how are you going to design a helipad? So, helipad is going to be designed, of course, with the weight of the helicopter, is it not, and another consideration to take copter load. Now you have to provide sufficient area; sufficient area to provide what is called air cushion; you know what is air cushion. Suppose in your helicopter you are trying to lift off, then you have the rotor actually gives a thrust. Now that thrust has to come from that helipad. Now if you have not provided sufficient area you will not get the sufficient thrust to give the lift to the helicopter. So, you provide sufficient area and the strength, of course; will be due to the copter load.

Now copter load actually there will be two types; one is you will find in the static case and there is also dynamic load because of motions. The dynamic is more permanent

because it is coming from vessel motions and also copter motions. So, those have to be taken care of when you are designing a helipad. So, you will find helipad is quite strong. It is not a very clumsy what is called a deck. So, these are the provisions to be counted if you design escape two helicopter. The other thing that you will come across is the load that there is typical load intensities are given for your design, but these are given in the British units.

So, load in civil engineering they call it dead load; that means loads which are not moving. So, these are items you write floor beams, then plates. Now these are designed for 50 pounds per square inch. So, these are design load. Now live loads or the moving loads, live load you write production equipment. Now live loads for bright for floor and beam design. Now wherever you have live loads. So, live loads are done by this production equipment. So, they have rotating machinery which gives you vibratory loads. So, if the live loads are located on the top of these floors and beams. So, they are to be designed for you just see this is for 350 to 500 pounds per square inch.

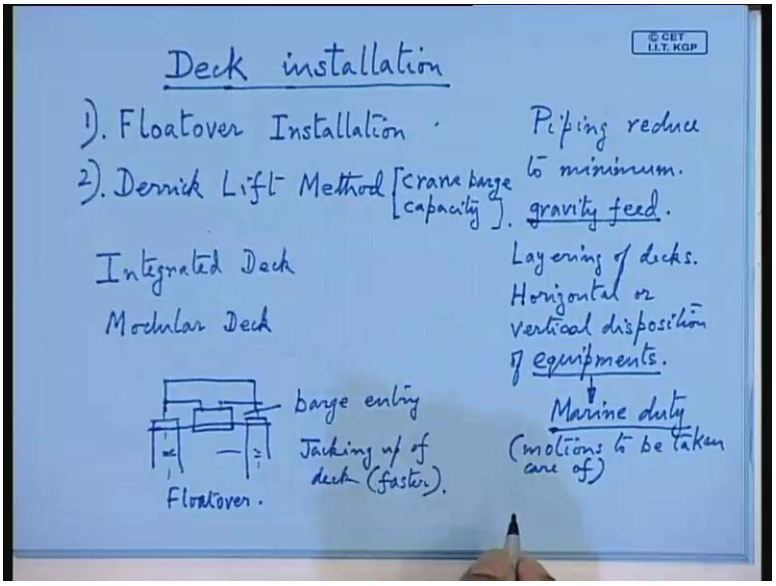
So, these are the design load or sometime this is called allowable stress. Normally it should be linear; it will come across if you open your load intensities, etcetera, you will find about allowable stress. So, these are actually your allowable stresses for all these structures, production equipment, then you have drilling equipment. So, these will cause lot of loads, especially your dynamic loading is going to come. So, you can see the static load is only 50 pounds for square inch, whereas, your dynamic load is in the order of 350. And if it comes to drilling then you are in more trouble; it is 1000 pounds per square feet; sorry this is square feet, f stands for square feet, so 1000. Then mud tanks I do not know why they are given so much of stress on the mud tank. So, this is 1250.

Then you have derrick load; derrick is coming from the cranes. Derrick load is 2500. These are of course, kilo pounds. It has given the load I think the total load. Living quarters is only 150. This is pounds; pound stress level is given. Now after you have designed this, now the deck truss, the supporting truss for the deck, jacket. So, these are carried down to lower levels; carry down to lower level means your deck load is automatically coming to where? I think you are not able to see this know.

Student: Yes, sir.

So, this is 70 percent; you take 70 percent of live load. So, now what is mentioned here is that the weight of this thing, the deck is ultimately you have to come to the deck truss and then it comes to the jacket, and after the jacket it comes to the pipe. So, once you go to the pipe then you have to take 70 percent of live load; so your live load that is these loads when you come to the pipe. So, ultimately these loads I have told you the loads are carried down to the foundation; your pile is the foundation. So, this is the one of the areas.

(Refer Slide Time: 45:18)



Then the other point that is to be remembered when you are designing a deck is deck installation. Now there are actually two methods I have told you. Now what are these two methods? One is called; number one is called the float over installation. Now remember all this. Now you see if the take design is not easy in your offshore platform for the simple reason is that you cannot in ships actually the deck is quite large, go and visit oil tanker, etcetera you will find is on nearly a playfield; that is your football four or five football fields, lot of area will be there. But in case of offshore platforms you are very tight on the deck area, then last class I told you because then you have to think about the horizontal how you are going to place the horizontal deck area allocations.

As you are unable to do this you go vertically up and then you have to connect. Because if you increase the deck area what is you are going to increase the cost of the platform, because that underwater truss that the size is going to increase. Immediately the size of

the underwater truss is going to increase if we increase the deck area. So, your tight on that, is it not. So, remember that for offshore platform cost is a very important factor in design because of the simple reason that one is the deck area and other for deep water if you go; that means, the length or depth of the truss is going to increase. As soon as we increase the size of the truss you are increasing the problems will be increasing.

First problem that is increasing in spite of your cost is overhead loading. Immediate increase will be there in the wave loading and that will give you a sequential increase in the thickness of the members of the truss. So, again you have to completely redesign the whole thing. So, that is a very important consideration; that is you should not go for the unnecessary increase in the deck area, and that is one consideration. Another consideration that most of you will come across is the piping. So, piping the most intelligent thing to do is cut down on piping or piping reduces to minimum; can you do this? So, that requires a lot of expertise, or you try to locate one equipment on top of another by means of what is called gravity feed.

You know what is gravity feed? If you have and if you see your motorcycle the fuel tank is located just above the engine. So, that means the engine is getting supply of fuel from a pipe by means of gravity, is it not? It is just coming flowing from the tank. So, here if you have this gravity field then that also reduces the piping to a large extent. This is also having two separate pure engine and fuel tank at rather two different locations are connect by pumps and piping to increase the piping as well as you will require pumps and all that. So, gravity field wherever possible you go for that. So, the main purpose is to reduce piping as much as possible, and once you reduce this automatically you can reduce your deck area.

So, deck area requirement is a major thing. Now that is why you will find in most of the platforms you will never see only a single deck, but there are different layers of decks. So, layering of decks is very important and connecting by your access or piping's and some equipment; that means you have to install not in the horizontal mode but in the vertical mode, say compressors. Compressors can be whenever you are layering of decks. So, that is important and horizontal or vertical disposition of equipments. Now this you find out disposition of equipments. So, that means from this you will find that some compressors or say heat exchanger, they can operate vertical instead of horizontal.

But if you place them horizontal you will find that your requiring a larger amount of deck area, but if you place it vertically, obviously, your deck area is less. Now the problems will come up when you have a compressor like this; that means you have to have a securing arrangement, is it not? You just cannot have a compressor located like this. So, it should have some fixing arrangement.

So, obviously, instead of one deck you are going to have two decks or you have number of decks with supports. So, these are some of the arrangements you can think about, because your space requirement is crucial, okay. Now most of these equipments are of you have to intend all these equipments. Either this is done by you or if you are not an expert; that means your official contractor will hire, say chemical engineer or a mechanical engineer who is going to intend these equipments.

And these equipments are all categorized as marine duty. So, this marine duty, say, pumps, compressors, engines. They are ships, the main engine that you are buying or your compressors, etcetera. They are classed as marine class or marine duty. Now this marine is, that means the ships should have lot of motions you know when it is going in the sea way. Now the sump of the engine has to be designed in such a way that the engine can take air whenever it is having a rolling, pitching and all these motions. So, in offshore platform the same things come across is this. So, here these equipments are to be designed to form marine duty.

Now the main thing is you will find this is motion to take care of motions, motions to be taken care of. So, both for the personnel as far the equipments this is very important. So, whenever you are designing equipments in offshore platforms I told you first thing you try to get the space require, because you are running short of space. First you try to make a layout with the horizontal layout you are not very satisfied; that means, this is going to push up your cost, then you have to design vertically all the decks, layering of the decks and how to fix the equipments with the associated piping and access plan that is going to come on the topsides.

So, topside layout is not very easy, and after you have done all this then deck has to be installed, is it not. So, normally what is done there is the underwater truss that is built separately on the ship yard that is floated out or it is carried by your that is the bars and then it is appended. So, decks are normally positioned on top of the platforms after the

underwater truss has been installed and properly secured on the sea deck. Now how are you going to install the deck? So, there are two methods of installation. One is called the float over installation, and the other one is called the layer I think it is called the Derrick lifting method, float over method and Derrick lifting method or rather you write Derrick lift method.

So, which one you are going to do? Now if you have a float over installation. Now first that means, your decks or topsides have to be specially designed for this float over or Derrick. The other, remember when I started my discussion, that means, decks are normally designed of two types. One is what? Integrated deck, I talked about this. Integrated deck as opposed to another type of deck which is called modular deck, is it not? So, here you see modular deck. Now next after you have done this. So, these two categories are going to decide on whether you go for a float over installation or a Derrick lift installation. Normally this modular deck you can go for Derrick lift method, but Derrick lift method if you go this is normally guided by your Derrick capacity your crane barge capacity.

And in the float over installation, float over is normally done by the deck actually being carried by barges, say barge actually you have to have a certain mockup for carrying the barges, and then this is positioned on your jacket columns. So, this is your jacket columns. So, your barge comes, and this is called the float over method. Now float over method if you design; that means the column spacing has to be made in such a way that barge entry is possible. Then you design the columns or space the columns in such a fashion that your barge can enter, and then it can devilish and position the deck on the top of the columns. So, this is called a float over method.

The other method, of course, is much more simpler. Now there are two types, float over also there are two types. One is you can ballast or deballast the barge, and the other is what is called the jack up or jacking up method, jacking up of deck. Now these actually the barge ballasting and deballasting is it is more time consuming. Now in case of influent weather where there is rough weather, you do the process very quickly. Normally the deck is carried on what is called your jacks, screw jacks. You just reduce the jack and then it comes and sits on top of the columns, and it is done very fast. So, this method is faster jacking up method.

So, all these things you go to the actual site where installation is taking place. Then you can a firsthand experience. In my class I am just exposing you to what is there in store. So, with this we finish our topsides; that are primarily topsides means topsides layout is what I talked about is you have the GA drawing. Now your next topic that I will discuss after a few minutes will be your mooring system; this is also very important.