Marine Construction and Welding

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Lecture No. # 01
Introduction to Ships and Offshore Structures

We will be starting with this program, marine construction and welding. Here, we will actually look into primarily the constructional aspects of marine vehicles; the constructional aspects means, or, the constructional aspects will also include your structural arrangements and their specifics, with regard to the functionality of the particular object or the particular marine vehicle, and their structural response against the service loads.

So, we will try to look into all these aspects as far as the marine vehicles are concerned; by marine vehicles here, we mean, primarily the ships and offshore structures, offshore platforms - we will keep ourselves limited to this. So, that will be one part and the other part will be the fabrication aspect. In fabrication aspect, we will deal with whatever things that come after the design is complete; after the design, working details are done in the design office, then actually, you will have to translate that idea to reality, means, you will have to have the product; till this time one can say that the things were in a so called virtual mode, that means, they have been drawn - it is only on paper or may be, in electronic mode.

But for the actual purpose, you need the actual product, that means, which will give you the service; say, transportation of wheat - you need a particular kind of vessel, or transportation of trucks, automobiles you need a different kind of, probably, a carrier. Once the designs are done, that means, your so called preliminary design, detail design everything has been done, then it goes to the shop floor. Shop floor will see in sequence what the kinds of activities involved are, and the shop floor we are talking about here is essentially the shop floor of a shipyard. A shipyard is a term where - though the name is shipyard, it does not mean that it only build ships - it builds anything which is in water, more or less; that means, offshore platform also is build in a shipyard, a submarine is

also build in a shipyard; one may name it as an offshore yard, submarine yard, but the general name is shipyard, that is a conventional.

So, that is what we will do; in constructional aspect, (( )) looking in the sequences will give little more extra emphasis on the joining aspects, that is, the welding; because as I said - once the design is done, once the plates or the materials have been acquired, cut to the required sizes and shapes, then you will have to put them together to get the entire final product: a particular ship, or a particular submarine, or offshore platform, whatever it is.

So, that joining technique used is essentially welding; we no more do riveting these days, I mean, no bolting as such; long back it used to be riveted ships, the joining was to be by rivets, now welding has advanced enough, so we do welding; there again, different kinds of welding techniques are used for different requirements. So, we will look into those aspects and finally, we will see, once the welding has been done, you will have to be assured of the weldment quality - the joint you have made, whether it will serve you the required purpose; the required purpose means, welding is what? Two pieces you are putting together to make one integral piece, so that integrity, how good is the integrity? How good is the welding done? Some quality tests, so we look in to what kind of tests are done.

All this we will talk, keeping our focus on ship building industry; because there are various other methods of welding, there can be various other methods of testing, but we will only talk about those which are rather relevant to the ship building industry.

So, that is how the entire course will be. Today, to start with, I thought it will be worthwhile to look into the sort of the products which we will be dealing with, classification of that; so, classification of that means - it is essentially types of ships and types of offshore structures.

As far as types of ships are concerned, one can classify in two types: one is the merchant ships, another is your defense crafts - the naval ships. The purpose of these two are definitely very different - merchant ships are primarily for purpose of transportation of cargo, and the defense naval ships are for defense applications.

From the design and construction point of view, there is no difference whatsoever, between these two types - merchant or naval ships, because both are made of steel or aluminum or any other constructional material; both are to be welded and both should serve the same, I mean, similar safety requirements should satisfy and so on, so forth, but the functional aspects could be different.

So, in any guess, we will not go in details of any of those naval vessels, there are different kinds of naval vessels; we will only talk about the merchant vessels. There is another kind of vessels also apart from these two, that is, the merchant vessels - to have them efficiently functioning - you need some kind of support vessel; so we will talk about what are those support vessels.

Again, another classification can be made - broad classification once again, that is, sea going vessels, inland vessels, I mean, within the gambit of your merchant vessels - there can be sea going ones, there can be inland ones; within the inland ones, again, you have small cargo carrier, passenger carrier. There can be another division which is from the pressure tourism point of view, pressure craft - crafts necessary for tourism purposes; that is another class. On top of that again there can be another classification of high performance craft; something called high performance craft or high speed craft.

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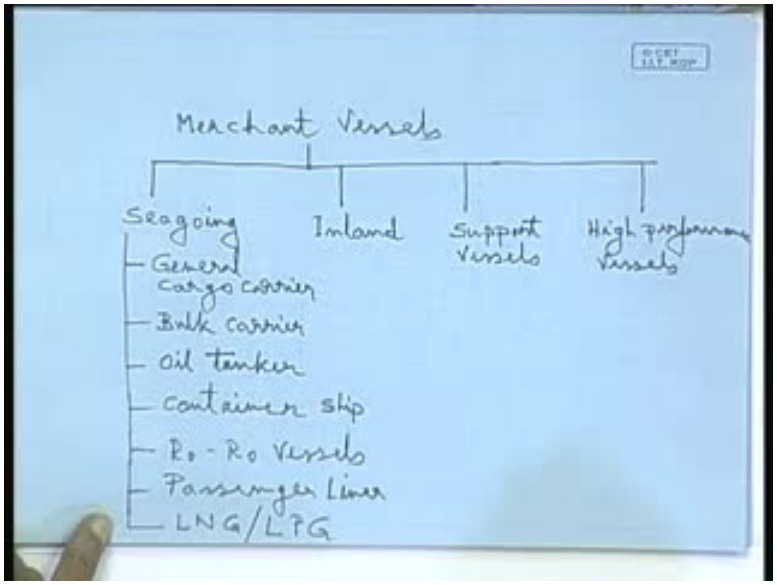

Broadly, I think we can go like this - if we just look into the merchant vessels, I am just giving the name merchant vessels for all kinds of vessels apart from the defense ones -

naval ones; so, in this - there will be seagoing, there will be inland, there will be support vessels, there can be what is referred to as high performance vessels.

This, we are basically talking to make you aware that what all kinds of vessels are there. Obviously, in the entire course, we will not be taking each one of them and talking about them, definitely that is not feasible; but, the basic principles of design, the basic principles of construction, the basic principles of welding, all remain essentially same.

But, once you will become a naval architect, it is expected that at least you will have awareness of all these types of vessels. So, that is how we could divide this merchant vessels in these four categories; of the seagoing, we will have further sub division; there can be many types of seagoing vessels, but we will concentrate primarily on these ones: the first and foremost can be referred to as general cargo carrier - a particular type of ship, as the name suggests, it carries general cargo - cargo of any nature, any type.

Another one is referred to as bulk carrier - that is essentially, cargo in bulk. For example, you are carrying wheat, say, forty thousand tons of wheat, you will have to import from Australia. So, what could be the means of this transport of this wheat? It can be - either pack them in bags, those gunny bags or whatever, pack them in bags, load it in a ship and bring it; if it is done that way, then possibly, it will be brought in a general cargo carrier; but if you have a ship wherein you have big holes like this room, say for example, even bigger, much bigger than this, wherein you just put the wheat in lose condition and bring it - that is bulk carrier, that means, you carry the cargo in bulk.

Obviously, the second option is much easier, or much more efficient than the first option, because otherwise, unnecessarily we will have to use so many carry bags wherein you have to first load, stitch it, and take it; so, not only it is additional work involved in loading each bag, stitching the bags, it also adds to the weight - a fictional weight of those bags itself. Instead, you carry the whole thing in loose; but if I put the wheat in a general cargo hold, then again may not be very convenient to carry, because that is not designed that way, functionally it is not designed. So, the bulk carrier come in to being because of this bulk trade; so, this bulk trade is going to exist; as long as mankind exist in this world, this bulk trade will exist.

That is how, this type of vessels developed over the years depending on the requirements - that is what is a bulk carrier; we will look into this in little more detail later, when you talk about bulk carriers, automatically implies - it is a dry bulk carrier.

Next comes, possibly we can mention the oil tanker - this is also a bulk carrier, but it is a liquid bulk carrier, so give a different name, oil tanker - there you carry oil. Primarily, by oil tanker, we mean the crude oil tanker - crude carrier, because there is huge straight of crude petroleum, crude transportation.

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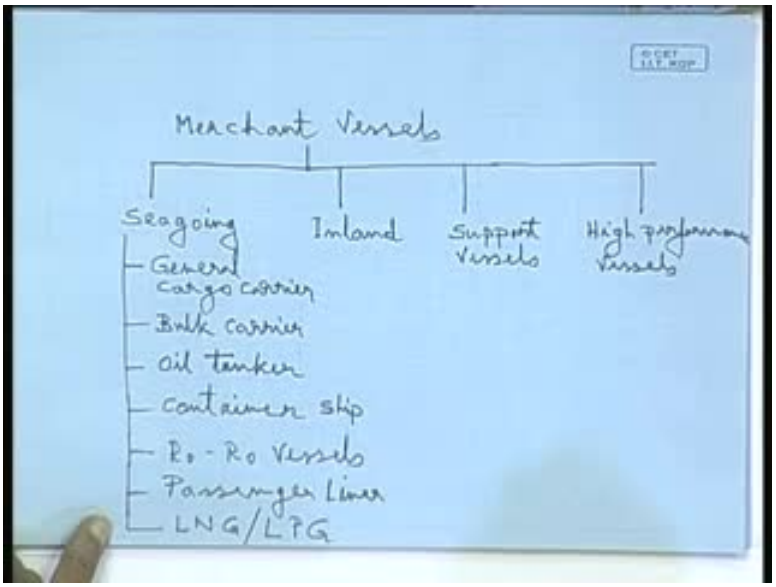

Obviously, there are vessels which carry the refined oil also, that means, the petroleum product, we are not going in that; broadly, we will talk about the oil tanker which is a crude carrier.

Then comes container ship; container ship, what is it? As you can see the name, it carries containers - what are those containers? You may have seen on roads or on rails those huge rectangular, cubical boxes - huge ones.

Instead of carrying the cargo in general form, in loose form - in general cargo carrier, you can carry anything; but anything means? Suppose the furniture of this room is to be transported and if I lift each chair individually and put it in a ship hold - that is the way a general cargo carrier is loaded, that means, each unit cargo is individually handled - so imagine, if I have to suppose transport these chairs and I transport one by one, that

amount of time it takes for loading and unloading; whereas if I have a box wherein I pack all the chairs and I just transport the box it becomes much faster.

That gives, I mean that particular aspect gave rise to this concept of containerization or container ships, because you know everything is eventually driven by economics - that is the bottom line.

So, what people found, that a general cargo carrier - the loading time and the unloading time may extend to the period of two to four weeks; that means, it calls on a port first, it unloads whatever product it brings and then it loads. The entire process may continue for four weeks - that means what? That four weeks is total wastage as far as the ship owner is concerned - he is not earning any money; rather he is paying because the four weeks he is staying in the port, he will have to pay the port dues. Instead, if he could have had cut it down to, say four days of stay in the port, then what happens - he pays less; not only that, he makes more number of trips.

When the ship runs in the sea, when it cruises, then only the owner actually earns; he is spending when the ship is sailing, definitely, because the fuel cost, the salary, etcetera; but that is an earning phase - because he is taking somebody's cargo and he will be paying. So, he would like to make more number of trips; how to make more number of trips? One way would be - increase the speed, another way would be - decrease the down time, it means, the ship is stationary - not sailing. Increasing speed could be option, but that comes at a cost - very high cost; you will learn later in your other courses that speed of the ship and the power required to deliver that speed - it increases exponentially.

From, say, 15 naught to 16 naught, it is not a linear sort of increment in the power requirement, it is exponential; so, there is a limitation - you cannot go on increasing the speed because power requirement increases, means, your fuel consumptions increases, your cost increases; that also you cannot go on infinitely increasing because there is a cut-off somewhere, beyond which, you put more power - the ship weight increases, it does not deliver the speed.

Because speed is also related to the weight of the bulk, the ship, so that is not an option; good option - to increase the number of round trips; so, one of the best option is to cut down in the port time, that can be done if I can cut down on the cargo handling time, that is the loading-unloading time; so, that gave birth to the concept of containerization.

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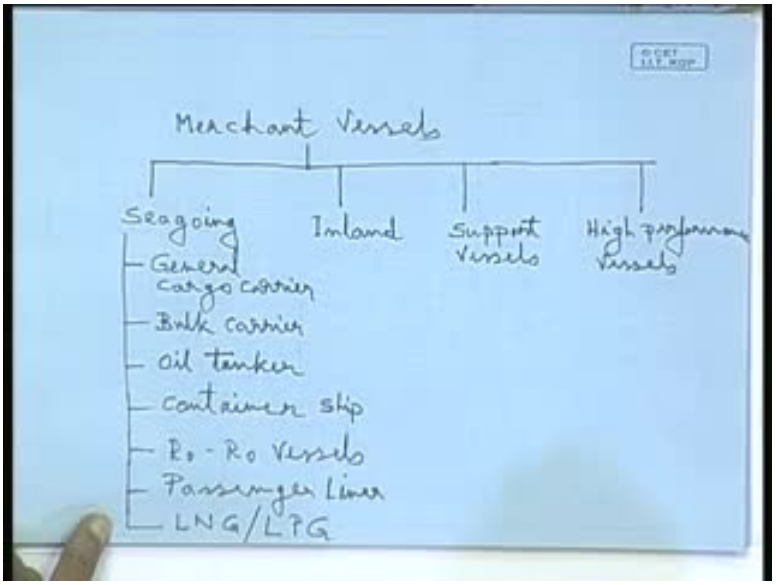

So what happens here? The containers are loaded on-board the ship; containers themselves come loaded from the consignee; whoever is, suppose sending some product, some machine equipment or whatever - he will take containers to his factory premises, load the containers and the containers are delivered to the port - and containers are put into the holds; same thing on the destination ports - containers are taken out, put on trailers and, goes to the port of I mean goes, straightaway goes to the customer for whom the cargo has been assigned.

So, what happens, in the process, since the containers are of identical size, standardized size, so you can have the enterprise of loading and unloading mechanized - it becomes very fast; so that is how, the concept of containerships came.

But, as you can see, as we are coming from general cargo, bulk carrier, oil tanker, container ships, basic purpose is same - transportation of cargo; but the functional requirement is changing because we are transporting different kinds of cargo, so that way, that has a bearing on the design of the vessel; we will see later how the design changes.

Another very popular important trade is import-export of automobiles, that gave rise to a particular type of a vessel, which is referred to as - ro ro vessel or ro ro ships, because, in global trade, automobile is one of the commodities which is very heavily, sort of, imported and exported.

For example, one of the biggest consumer of automobiles is U S A, so they themselves are manufacturing many cars, many automobiles, but they also import many from Europe, as well as, from Japan; so, there is a huge trade in this. How do you transport these automobiles? You can put them in a container, but not all kinds of automobile may fit in a container; so, putting in a containership may not be very viable; of course, in the bulk carrier, does not arise question of keeping the automobiles; by this automobile, I mean, it can be trucks, it can be passenger cars, which are self-propelled by themselves. In a general cargo carrier, again it will not be very convenient.

Here, what we will have to see in ro ro vessels or an automobile carrier is, that how easily, again the same question, how easily you can load the cargo and how easily you can discharge the cargo and in between stage after loading and discharging is the safety of the cargo demats? So, how to do that? Since the automobiles can roll-off themselves, so that is why, they are called roll-on roll-off ships - that on and off I have deleted, and I said ro ro ships in short; actually, the ro ro - that name was derived from roll-on roll-off.

That means, the car rolls on the vessel, docks itself there, wherever it is assigned; when the vessel calls in the port of destination - it rolls out; so that is how, your loading-unloading becomes very easy, very convenient.

So, that is the functional requirement of this vessel, that the car - the cargo, will roll on the vessel, will keep it stationary during their entire voyage, and again unlock itself and roll out; so, the functional requirement - based on that, you will have to design accordingly.

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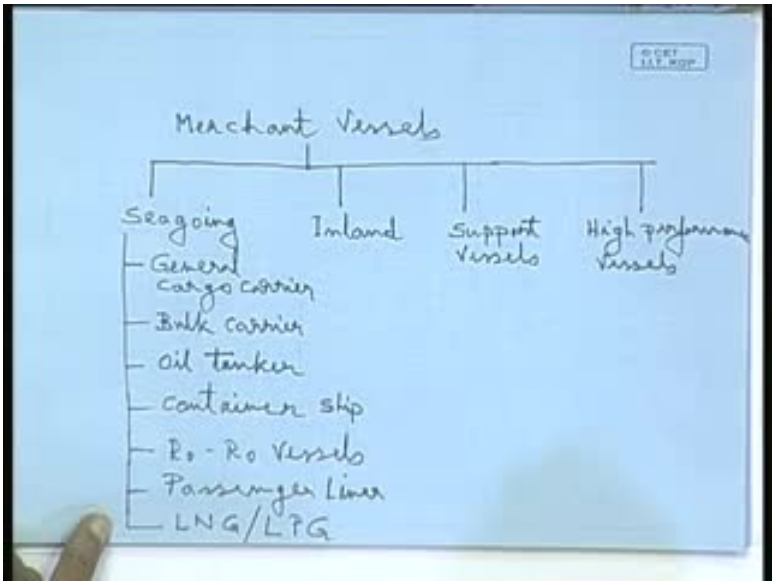

Immediately one thing comes to the mind, that this kind of vessel should be a multi-deck vessel; several decks should be there, because in each deck there will be several cars. In a bulk carrier, you do not need decks because entire cargo is put in bulk; in oil tanker, you do not need decks; so, the functional requirement automatically gives you clue - how the internal structural arrangement should be.

Also, you can see a bulk carrier or an oil tanker, the port through which you will put the cargo and the port through which you will take out the cargo again, will be different compared to a container ship, will be different compared to an oil tanker or a ro ro ship; so, that means the functionality, that is why I am saying externally it may look all identical, but because of the functional requirement, internal arrangement will be different. We will look into those structural arrangements; so that is ro ro vessel.

Then possibly, you can talk about the passenger ships or passenger carrier or also referred to as, passenger liner. As you know, long back when this aviation industry did not mature that much, passenger transportation - also used to be, you cross a continent - it used to be by a ship; that means, the cargo was passengers.

Today, of course, passenger liners no more as such, serve that purpose, but again it is becoming gradually very popular in the tourism sector - that means, for holidaying, for sort of leisure purpose, people go in this passenger liners for spending some good time.

Well, these are also huge vessels; obviously, here the cargo is the very delicate cargo – passenger, human being, so accordingly, you will have to provide facilities. In other cases, the cargos are not that delicate yet; in oil tanker some delicacy is there - you will have to have proper vent mechanism so that (( )) fire hazard. In ro ro vessel cargo is again delicate from other point of view - cannot afford damage to any car while handling, there cannot be any single scratch in the body - that way it is delicate; as well as, they are rolling-on and rolling-off, means, they are on their own engine power within a confined space.

So, question of ventilation is very important because the pollution, say, a ro ro vessel with capacity of 2000 vehicles; so, 2000 vehicles will come inside a very confined space, each will have fractional amount of C O emission, you can imagine the polluted environment in that; so, the driver of the last car, when he parks the car and goes out, he may get fainted, because it is already so much heavily polluted inside; so, all those aspects are there.

Passenger liner is the most delicate cargo, so obviously, you will have to provide for him the best possible comfort, and all those other aspects, because here we will have to keep in mind, the passenger line as primarily being used for leisure purpose; so, comfort of the highest ordered is needed. Obviously, safety in other vessels is also needed, but here the safety requirements are still more stringent because here many more human lives are concerned; so, that is the passenger liner.

Probably, it will be worthwhile to mention, there is what is referred to as LNG LPG carrier; LNG and LPG carrier. You have any idea of what is this LNG - Liquid Natural Gas, similarly, Liquid Petroleum Gas. So, there is also some bit of trade, intercontinental trade, in this particular product. If you have to transfer a Liquid Natural Gas or Liquid Petroleum Gas, obviously, none of the above mentioned vessels are suitable.

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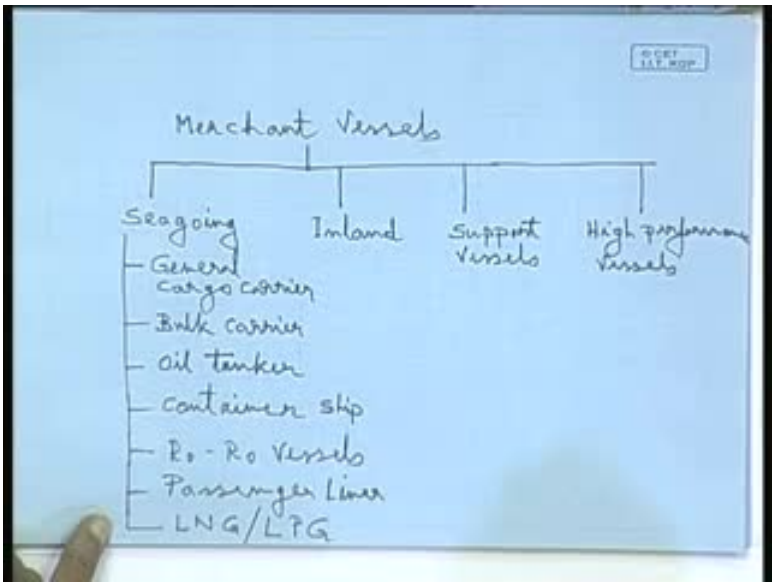

What is the fundamental difference in this particular product compared to all other products above? That is the requirement; I am saying - fundamental difference of the product, that is, the requirement of product's storage; or product's storage is the fundamental difference in the product.

Liquid, it is not gaseous; there is another liquid also, oil tankers; so, could I have taken it in oil tanker - definitely not; so, what is the fundamental difference?

Fundamental difference is - fundamentally, this cargo is a very low density cargo, even in the liquid form also - it is low density; and second, the temperature of the cargo. These are the two very fundamental aspects - the temperature of the cargo and its very low density.

So, what is happening in the process? You know, in ships, there are some requirements of, what is called, load line requirement; load line requirement means that you are not allowed to load a ship beyond a certain loading point, beyond a certain capacity; beyond a certain capacity means what? Means, you have designed the vessel and you will have to, sort of, define the full loaded draft; that means when the ship is, say, a particular ship is designed of carriage of ten thousand tons cargo, that means, in the departure condition, the maximum weight of a ship is when, at what point of time you have the maximum weight of total weight of the ship? This weight of the ship is referred to as what - displacement. There is a term called displacement. We do not say the weight of the ship,

we say, displacement of a ship. Why this term has come, you know? Can you guess? It displaces the water, equal amount of water; that is how this term is used - displacement.

Can you tell me when a ship will have its maximum displacement? During departure, loaded departure; there are various stages: loaded departure, loaded arrival. These two are different, there will be difference in weight, because in loaded departure condition you will have the entire fuel stock, you will have entire fresh water stock, you will have the entire provision stock, everything is full. Loaded arrival - many of these things have depleted to a bare minimum level; so, this loaded departure condition - at that condition, the ship should be floating at a certain draft, which is already predetermined.

You may have empty spaces available in the ship, but you cannot load further cargo; then what happens - the ship will sink beyond that line which has been prescribed, that is the load line, also referred as Plimsoll line.

Why? Because from the safety aspect, there is a requirement of what is called, freeboard. These are, of course, you will learn all these elsewhere also, but I am just, may be it is worthwhile to mention.

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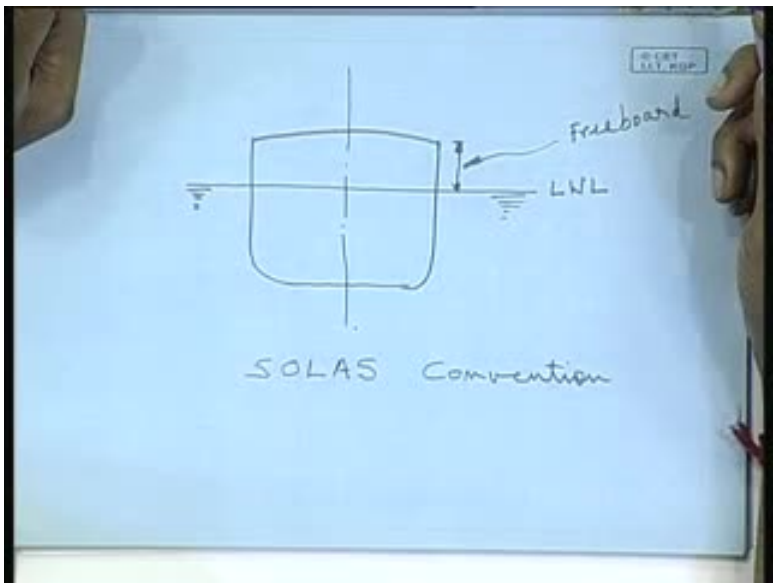

That what I am drawing is just a section at the mid length of a ship; externally you can see like this, so this is your, let us assume, that this is my LWL - Load Water Line at the loaded departure condition; so, this distance - the distance from the deck at side to the

load water line, this is referred to as freeboard. There is a specific requirement that the freeboard could be less than so much.

There is something called SOLAS - Safety of Life At Sea. There is SOLAS convention - this particular convection outlines or gives the guidelines of various safety features, safety aspects, which are mandatory, which we will have to follow while designing, while operating and all that.

Because human lives are at stake, so this SOLAS convention prescribes freeboard - that for a particular type of vessel, this must have to be the minimum free board, it cannot have less than that. When it may become less, suppose I have loaded - I over loaded; so, over loading is not only a problem of structural point of view, but it is a problem on the safety point of view, so that is not permitted.

Anyway, so what happens in case of higher density cargo? You load to a certain extent, I mean, that way you design and your vessel very easily attains the load water line, or it may sink to the required draft; but in case of LNG and LPG carrier, it hardly sinks to any draft unless until, you really load a huge amount of the cargo, because the density is very less - of the order of 0.5 or so.

So what happens, LPG LNG carrier? Here I have drawn, only little bit is above the water, major part of is below water, but in LNG carrier it can be otherwise - much above will remain; that means, there freeboard is no problem, there is other kind of problem coming in to picture - there is too much of exposed area above water level, means, too much of wind force will be working; so, that I can give another design problem.

Then, of course, the cryogenic temperature - low temperature means, it is literally, substantially subzero temperature. Cryogenic temperature means, accordingly, you will have to have all those required thermal insulations and containment systems; so, that is how they classify itself as very sophisticated vessels and it needs special attention, obviously.

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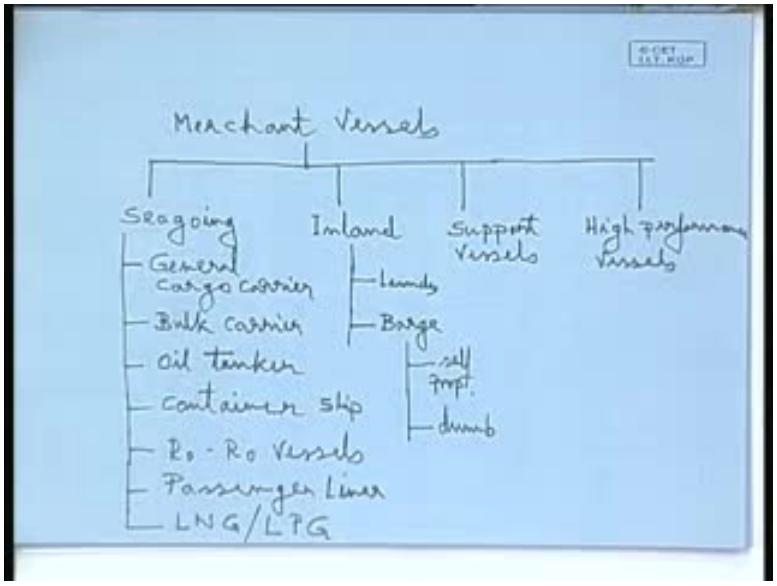

So, broadly we can say, the sea going merchant vessels can be classified - in this probably, we have done it in six different heads. Let us take a quick look at the other ones - the inland vessels.

In the inland vessels, we have the river crafts, what are they? The river launches, the launches for small time - for ferrying of passengers across the river, or along the river; then, through inland water also we transfer cargo, so we do not name them as cargo ships, but we name them as barges, barge; we call them as barge.

So, these barges could be self-propelled or could be dumb barges; that means, it can have its own propulsion mechanism - so it becomes a self-propelled barge - that is, a miniature version of ocean going ships, a cargo ship; then, dumb barges - dumb barges means, it does not have any propulsion mechanism. It has only cargo holds where to load the cargo; so, you will have to have another prime mover or an order vessel which will push it or pull it through these dumb barges, those come under the support vessels; so, in inline - primarily these two, launches and barges.

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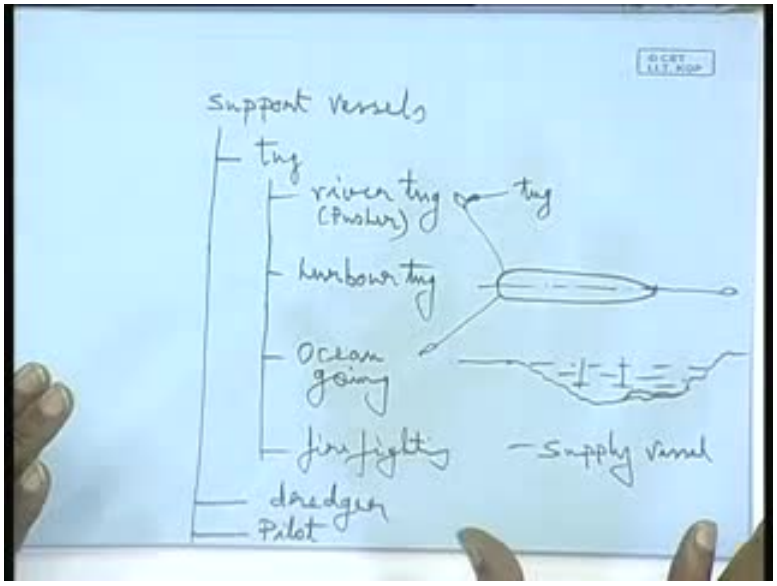

Then we come to support vessels which provide for, I mean, helps in the proper operation of the sea going vessels, inland vessels etcetera; they provide support. We started with the merchant vessels, naval vessels; naval vessels - it is a very specific function; merchant vessels primarily trade – primarily, transportation of cargo. All the sea going vessels, what we have just now talked about, all are basically cargo transportation; inland vessels also, we have talked about, is cargo because launches - passenger cargo, barges - general cargo.

Support vessels - they are not for any so-called cargo transportation purpose, but for facilitating this process. So, first and foremost, support vessel could be referred to as tugs - tug t u g. The function of these tugs are, like I said, that if we have a dumb barge - it can be a one dumb barge or there can be couple of them put together, there can be various configuration of barges put together - and one tug pushing it, we call it a pusher tug; so, this is a kind of a support vessel, that means, it moves there. Another support this tug can provide is - when a big ocean going vessel enters a port, you will have to berth the vessel, means, parking of the vessel alongside the bank, which is called quay or the berth, because it has to be on the shore side, such that, your unloading loading can be done easily.

So, how to move that big vessel? Say, a hundred thousand tonner bulk carrier is coming. If it operates its own propeller, own propelling equipment and maneuvers it to come to

that position, it may not be able to do so, because, you must realize, that the breaking mechanism is not as efficient as compared to the surface vehicles. With that inertia, it goes and hits the quay - that will break, also this ship will be damaged, so what is done generally? The vessels are maneuvered with the help of tugs; so, another support the tugs provide apart from pushing the dumb barges - they help maneuvering the vessels in the port area.

So, a configuration like this, what I have drawn is - these are the tugs, this is a big vessel, in comparison the tug will be this form; so two tugs pulling the vessel from the back side, another tug pulling it from the front, so that to keep the right course and slowly takes to the desired destination, wherever.

So, that is how I have classification - as a river tug, which is essentially pusher tug for barges; then you can have harbour tug; that means these tugs, their primary function is to maneuver big vessels within harbour. There can be now ocean going tugs; what is this ocean going tugs? The first two tugs we have talked about, they will be operating in sheltered water - river is also sheltered water, harbour is also sheltered water; but when you go in an ocean, it is not a sheltered condition - you will face the ocean conditions.

So, this is a different class of tugs which are referred to as ocean going tugs. For some purpose, you need to pull a vessel right up to the ocean, or for rescue purpose also you may need; some break down has taken place, a tug goes out in the ocean and pulls it back; by this ocean it does not mean really a mid-ocean. A tug is not necessarily supposed to go to mid-ocean, means, thousands of miles away from the coast; not that way, but definitely, in the ocean atmosphere to be capable; so that is an ocean going tug.

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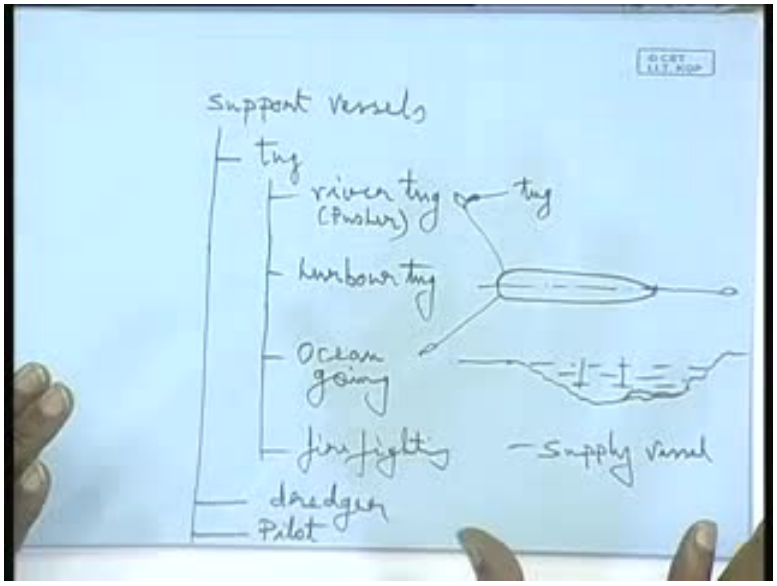

Then you have firefighting tug; by firefighting tug means - all the above three tugs can be a fire fighting tug - that means, tugs along with having the facilities of firefighting; there is a fire in a vessel, the tug will go and douse the fire. So, that is one of the support vessels.

The other support vessels are - there is something called dredger which dredges; the name, very name dredger means, for example, like the harbour or the port is little inside from the sea that is connected by means of a river or canal or channel; so, we will have to always maintain the required draft in those channels or the rivers, such that the designated vessels or the required capacity vessels can sail through that; as you know, there is always a sort of this phenomenon continuous, that is, siltation.

Because of various other factors, siltation of rivers takes place, siltation of canals takes place. Because of this siltation, the draft availability or the navigability of the rivers or canals becomes poor; means, if we do not have the required draft, a vessel cannot move, so we will have to clean that silt physically - have to grab, take the silt up, and throw it elsewhere. So, that is been done by vessels called dredger which dredges. The dredging operation is basically digging up the silt and removing it, so have a support vessel called dredger.

Another support vessel is pilot vessel; this is nothing, but the pilot travels from the port to the ship. When a ship enters the port area from the oceans, at some designated point

pilot takes over from the caption of the ship; he guides the vessel to the port because he knows this canal or the channel through which the vessel will sail and enter the port; because as I said dredging does not mean that the entire river geometry

Say, the river bed is something like this, everywhere you do not have the sufficient draft; a certain region, probably, you are maintaining navigable. It cannot go on tracing the entire width, so in navigable - within the river or within the channel, a navigable canal is maintained that the pilot knows very well. (Refer Slide Time: 45:05)

So, he takes over, he guides the ship through that navigable canal, why is this so important? You have any idea, why is it so important? Because if you do not do that, the vessel may get grounded; a term used - grounded, means stuck in the silt; stuck means, it will sit on the silt suddenly. Suppose, the draft is less, it goes and plows in the silt.

So what is the problem? It is not only the question of coming out, it may tilt and capsize immediately, why? That we will learn later, because its floating condition has changed; it was stable when it was floating; a ship has to be stable. It is in a stable equilibrium condition- that mean - if some disturbance is given, some tilting force is given, it comes back to its original position, that is, stable equilibrium. When the external force is removed it will came back to its original applied condition; so that happens when it is in the floating condition.

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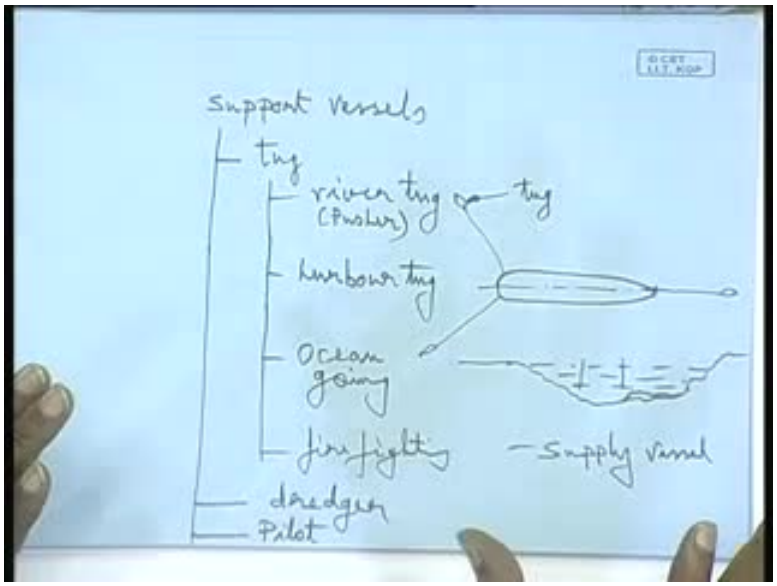

But the moment it touches the ground, then the floating condition changes; all those parameters changes, it becomes unstable and may capsize, so that is very important. So that is what a pilot vessel is - the pilot travels. What is so important about it? Because it is essentially ocean going vessel; because it will face the wrath of the ocean when the vessel is waiting out at the ocean, not in the slitter water. So, this is one of the support vessels and there is other type of supporting vessel, which is referred to as supply vessel.

Supply vessel which is used to supply provision and other equipment to offshore platforms.

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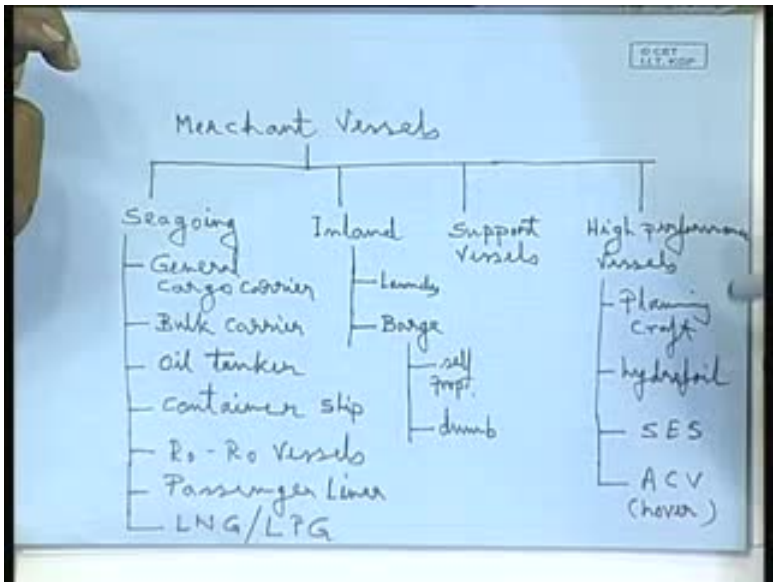

So there can be some more other support vessels, they are the general ones. High performance vessels, which are they? They are essentially the planning craft, referred to as, planning craft; another one is referred to as hydrofoil craft; there is something called SES - Surface Effect Ship; there is something called ACV - Air Cushion Vehicles or hover craft; so, these are some of the high performance crafts.

What is the difference, why I have classified them as separate? Well, because they are high performance; what does it mean - high performance? it means - no, speed is a relative term; in case of ships we talk about speed length ratio v by root over l; that comes from the float number v by root g l, g being constant, v by root l; so, that is what is referred to as speed length ratio. Depending on the length, for a given speed, it may fall in the high speed zone; it may be classified as a high speed vessel.

So, in high performance, primary difference is that they are very weight sensitive vessels - that is number one. Their mode of operation is not only the buoyancy force which is acting, which is holding them in water; rest all the vessels which we have seen: the sea going vessels, the inland vessels, the support vessels, all are supported by buoyancy force only - they are floating, they are following that great Archimedes principle. But the high performance vessel, when they are performing, when they are cruising, part of the weight is supported by a lift force - something equivalent or something similar to that of aircraft.

The aircraft does not float in water, it is supported by a lift force in air; it is not because of its buoyancy it floats; same thing in high performance vessels, this planning craft or hydrofoil or ACF or ACV, all these - some kind of lift force, apart thrust is generated in the hull, thereby the weight of the vessel is fully or partly supported by the thrust - that lift force, and rest supported by buoyancy; that is how, they are called high performance vessels.

So, what is the great fun about it, what is a big deal in this? The big deal is, the moment it gets supported by lift force means, the entire thing is not supported by buoyancy; that means, the vessel is much out of the water - lesser part of the vessel is touching the water, that means, lesser frictional resistance; the moment you have lesser frictional resistance, for the same power, you have higher speed, simple; that is how we attain a high speed, that is how the aircrafts fly at so high speeds, because the frictional resistance is very nominal - it is only the air resistance. That is the way we will find, there is all these aircrafts, they are trying to go up, as up as possible - 30000 feet, 38000 feet, where the air is less denser, lighter - the more lighter it is, lesser resistance - so it tries to pick up the highest altitude, as fast as possible, and then cruise though, it attains higher speed or lesser fuel consumption. So, that is what is this high performance vessels, of course, in detail, you will learn in later courses.

Another fundamental difference here till this point - seagoing inland vessels and support vessels, all are so called displacement craft, they are referred to as displacement craft, why? Because they are supported by buoyancy force and so, thereby we see that they are not generally weight sensitive; the weight is not a very important criteria - it is important criteria, not very important - but in case of high performance vessels, they are very

important because if your weight becomes little extra, it will never come up, the lift force will not be able to push it out of the water.

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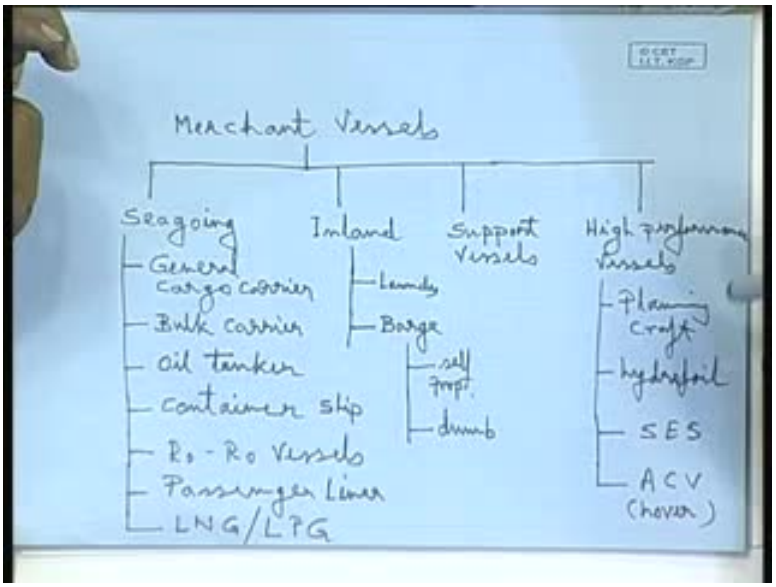

So, thereby one will have to take care of the constructional material of this. It cannot think of using steel or such heavy dense material for building of such craft, you will have to use a lighter material; so, that is how we see that this is the primary classification of the merchant vessels of the ships.

So, we will continue in the next class.