

**Port and Harbour Structures**  
**Prof. R. Sundaravadivelu**  
**Department of Ocean Engineering**  
**Indian Institute of Technology Madras**  
**Module 01 Lecture 01**  
**Layout of Ports**

Good morning and happy new year to all of you. This class will be held in tis NPTEL studio on Mondays, Tuesdays and Wednesdays we have about 40 lectures.

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First lecture is on layout of ports. In this introductory lecture I will be giving you, what are all the different layouts that is used in ports. We will also explain the two terminologies: what is port and what is harbour.

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**PORT:**

- is a place where vessels may discharge or receive cargo
- it may be the entire harbour including its approaches and anchorage or only the commercial part of a harbour where the quays, wharves, facilities for transfer of cargo, docks and repair shops are situated

**HARBOUR:**

- Any protected water area affording a place of safety for vessels.

NPTEL Department of Ocean Engineering, IIT Madras Prof R Sundaravadivelu Department of Ocean Engineering, IIT Madras

First let us discuss what is port? Port is a place where vessels may discharge or receive or and it includes the entire harbour including its approaches and anchorage or only the commercial parts of the harbour, where we will describe about these items quays, wharves, facilities for transfer of cargo and the harbour is a place which is a protected area where the vessels will come and the discharge cargo. About 90 percent of the cargo are being transported through the ports and harbour so that shows the importance and the growth of the port and harbour is phenomenal in the last 5 years. It is going to be double in the next 10 years.

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**DEFINITIONS OF PORT COMPONENTS**

The diagram illustrates the components of a port. A vessel is shown on the left, and a berth structure is on the right. The area between the vessel and the berth structure is labeled 'VESSEL'. The area on the right side of the berth structure is labeled 'HARBOUR'. The area on the left side of the berth structure is labeled 'PORT'. The berth structure includes a 'BOLLARD' and a 'FENDER'.

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Now we will uhh discuss about definition of ports components, as you see in this slide, the whole area is called as a port. The area on the see side is called as the harbour. The area on

the land side is called as the birthing structure. Here, you have the vessel which is standing here and here you have a birthing structure which can be made of steel or made of concrete and we have two important components in a port and harbour structure. One is called as a bollard; another is called as a fender.

The bollard is used to tie the vessel so that the vessel remains in position. The fender is placed in between the vessel and the berthing structure so that the vessel will not heat the structure directly. The vessel heat the structure directly damage can happen to the structure as well as to the vessel. So what we are providing is a fender. The fender consist of a cylindrical member like this. It can be cone and then we have a frontal board. The frontal board normally takes care of the water level variation.

What is shown here is the water level? This water level can go up and down depending on the tidal variation and when the water level goes up, the vessel also goes up. The water level goes down, the vessel also go down and we will keep the fender generally above the mean see level. Mean see level is a average water level, we keep the center line of the fender in between the mean see level and the high water level so that we can fix the fender in the board. Normally 2 third is below the center of the fender and one third is above the center of the fender understood now. Fender is the fender board; this is called as the frontal board. This frontal board is not central to the center line of the fender, one third is above the center line, two third is below the center line. When we talk about the port components we have two parts one is the harbour side, another is on the berthing structure side. Here, we will have the cranes to take the load and we may have other facilities also. So combine together harbour, berth structure, loading and unloading equipments, we have customs and other uhh areas together is called as a port.

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Now we will see India. India the port administration is done in two categories, one is the major ports. The major ports are in the coastal states. We have 9 coastal states west Bengal, Odisha, Andhra Pradesh, Tamil nadu. These are the coastal states on the east coast. Then we have on the west coast Gujarat, Maharashtra, Karnataka, Kerala, then we have Goa. So 5 coastal states on the west coast and 4 coastal states on the east coast. Totally we have 9 coastal states out of these 9 coastal states we have in Tamil nadu Chennai port, west Bengal, Kolkata and Maharashtra Mumbai port. These were the pre-independence port. How pre-independence we last Karachi to Pakistan then we have one major port that is at Kandla.

So I said two categories one is the major port. The major ports are developed in each coastal state by the government and these are controlled by board of trustees and generally the control is with the central government. Then we have non-major ports. The non-major ports are controlled by merit time boards under state government. The first merit time board was established in Gujarat is called as the Gujarat merit time board, then we have Maharashtra merit time board, then we have Tamil nadu merit time board. Two thirds of the cargo are being handled in major ports and one third is being handled in non-major ports under states control. This scenario will change 50 percent will go to major ports and 50 percent will go to non-major ports within about 5 year's time in all the ports together and this major ports which are initiated in each state I will describe one by one.

We will start from this end; we have kandla which is the major port in Gujarat. Then in Maharashtra we have Mumbai, but subsequent to development of container containerization, a new port has been developed in JNPT Jawaharlal Nehru port trust. This was originally

called as Nhava Sheva port trust between islands Nhava and Sheva. This is the biggest container port in India JNPT. This is handling about 4 million TEU. means uhh 20 foot equivalent units, 120 foot equivalent unit that is 1 TEU is equal to approximately 12 to 14 tones depending on the type of cargo, which is stored in the container.

Then in Goa we have the Mormugao port. This is there for a long time, but subsequent to independent. The lot of development is taking place. In Karnataka, we have a port which is called as a Mangalore port old Mangalore port but, they have started a new port which is called as a new Mangalore port. One of the best location for a port in India is Cochin. It is a natural port. It is located at Cochin. Then in Tamil nadu we have 3 major ports one is Ennore, another is Chennai, the third one is Tuticorin.

Ennore has a different concept of management. This Ennore is uhh called as Ennore port limited whereas other ports we call them as Chennai port trust, Tuticorin port trust like that. It is trust whereas Ennore port is Ennore port limited. Then in uhh Andhra Pradesh we have a port called as Vishakhapatnam port and strategically we have some importance for the ports navy is being uhh one of the prime users for the ports. On the east coast Vishakhapatnam is the major hub for the navy under the east coast we have uhh Vishakhapatnam under the west coast we have a place called as Arvar (8:56) and uhh this is being developed as a navel hub. Then in Orissa we have a port called as Paradip port, then in uhh west Bengal we have a Kolkata and Andhra (9:09). These are the major ports.

Now I have completed definition of major ports that have been developed. The other uhh non-major ports. The maximum cargo is being being handled in the two gulfs. This is called as uhh gulf of Kutch is called as gulf of Khambhat. The blue color indicates the major ports. The red color indicates the minor ports. It does not depend on the volume of cargo handle it depends only on the management that being used for this coast that only defines what is major and what is minor port.

The first major port the uhh major port, which is handling the maximum capacity is Kandla port. This only handles the maximum cargo in India, is uhh approximately about 80 million tones are being handled the Kandla, it the major port handling the maximum cargo. For containers JNPT is the maximum handling 4 million TEU, which is approximately equals about 45 million tones.

The next port which handles maximum container Chennai. When you talk about the minor ports there are certain ports which are being developed on the east coast. One is called as the gopalpur. The next is Kakinada, which is already in operation. North of Ennore we have a port called as Kattupalli, which is being developed by uhh L&T Larson and tubro (10:55). We have a ship building facility also being created, north of Ennore where we have the Kattupalli port. What is the importance of port? Suppose that tuticorin port is being developed. The land adjacent to that is being used by many industries. Some of the industries which are being developed near the port are our plant, as (11:21) power plant needs water for cooling water.

So when you need the water from the sea, it is preferable to have the port to have the industry very close to the port. The other requirement is all the power plants coal base power plants need coal from far away distance. For example, we have power plants near Chennai and tuticorin, both this powerplants are getting coal from paradip port. We have a coastal transport coming all the way from here to Chennai and we also have for uhh coastal cargo or sea cargo coming from paradip, but when it comes from paradip to tuticorin. It comes like this and then goes around Sri Lanka and comes to tuticorin. The reason is we do not have adequate draft along this alignment, which is proposed for saidusumitam (12:26). So the cargo has to come paradip all the way like this comes to tuticorin.

Many industries are also developed very close to the port, because industries need raw material which will come by ships and once they complete the finished products then it will go by containers or uhh general cargo to far away countries. So that is a reason the ports are important, each port as a hinterland. If we see kandla, the hinterland goes all the way to Punjab all the way and other agriculture products are getting transported to kandla. So for economic growth of a country we need port development. Any questions in this?

Vallarpadam terminals in Kerala (13:23)yes. Is that the largest container terminal? The largest container terminal is JNPT only. The next is uhh Chennai. Next we can say vallarpadam terminal is a largest container terminal. In L&T Kattupalli project which is uhh north of Ennore. There also we have Indian terminal. Ennore is also having a container terminal. Normally the container terminals are uhh becoming bigger or smaller depending on the length of the berths that is available.

If we see uhh Mumbai, the length of the berths container berth available, may be around 3 kilometers that is our IIT, if we see in get to kaveri hostel (14:12) that much distance we

will have continues berth. In Chennai, it will be for about a kilometer we have two terminals, I will show it in the next slide. Uhh the first terminal is about a kilometer, the second terminal is about 800 meters. Vallarpadam will be very close to 800 meters. The containerization if we see it needs lot of uhh linkages; one of the important requirements for any port development is the connection between the port as well as to the hinterland. We see the national highway project in India all the national highways, they will have road, which will be connecting from the national highway to the port, each will be connected be a national highway.

The containers will be transported both by rail as well as by road. Another mode of transport is land water transport. The cochin one of the (( ))(15:13) is the road development. So once we have a very if we know uhh the national highway in Kerala, it is not having 6 lane road. There are many places; it is having only two lane roads. So for container to go and (eva) get evacuated, we need this 6 lane highway.

One of the important uhh development that has taken place in port development is what is called as PPP? PPP means public privet partnership scheme. In a vallarpadam terminal in cochin is developed as a public privet partnership scheme that means uhh all the infrastructure required for the port will be developed by the privet operator and the dredging navigation channel will be done by the government of cochin (( ))(16:04).

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**CHENNAI PORT**

- **Location**
  - Latitude : 13°06' N
  - Longitude : 80°18' E
- This port has 3 docks : **Dr. Ambedkar, Jawahar and Bharathi Dock**
- It has 23 berths
- The major commodities handled at the port are Containers, automobiles (export), POL, Iron Ore, Fertilizers, General cargoes.

NPTEL Department of Ocean Engineering, IIT Madras Prof. R. Sundararajan, Department of Ocean Engineering, IIT Madras

Now we will move on to the next slide, we will discuss about Chennai port. In each port we have different components. One of the component is a dock. This dock is designated area we are calling this as Dr. Amberdkar dock, Jawahar dock and Bharathi dock. We have shown the

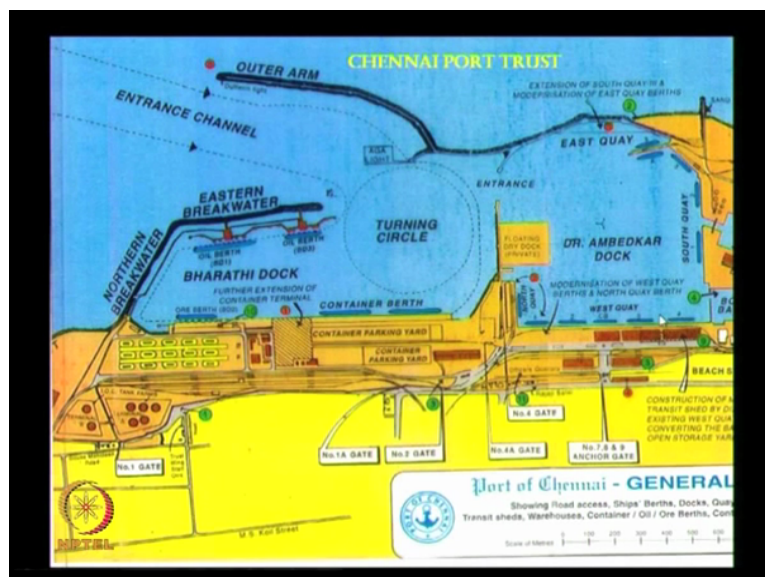


latitude, longitude here. This has about 23 berths, whenever we say a port what are all the commodities that is handled. The commodities that is handled are containers, automobiles.

Chennai is the hub of automobiles in India. So we have two export berths one is a Chennai another is a Ennore. These are dedicated berths which are used for exporting the automobiles. Then we have called POL. POL means petrol, oil and lubricants. Oil means is a crude oil, which will come then we will have a refinery. The refinery will process the oil and then they will have the finished products like petroleum, which will be exported. So we will get the crude oil and have a refinery, then refine the crude oil and export the petrol and lubricants.

Then we will have the iron ore berths. The iron ore berths are generally in India is used for export. The export is going to mainly japan and china. Then we have fertilizer. The fertilizers are important cargo that is required for development of the nation, mostly (17:48) agriculture country the import of fertilizer is one of the main components. Then we will have the general cargoes. General cargo we can have wood, scrap many things can be classified under general cargo, one of the thing which is missing here is a coal. Coal is also important in Chennai. We have the clean cargo, clean cargo is called as containers, automobiles we have dirty cargo that is iron ore, POL are dirty cargo. Chennai is very close to the main city. So we want to face out iron ore and POL from Chennai port which will go to Ennore.

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This shows the layout of Chennai port, I was telling about uhh 3 docks. This is called as the Bharathi dock. This is called as Jawahar dock, I am sorry Amberdkar dock and we have one more dock here beside, which is called as a Jawahar dock. Originally when the port was



established we have uhh nom (18:50) which was extending like this, subsequently we have built the break water like this and the entrance was here, originally entrance was here, but subsequently it was changed here, I will explain why it was change later and this is called as a inner harbour originally. Inner harbour means the water depth is limited support about 9 to 12 meters inside Amberdkar dock.

The dock means a protected area for the vessels with the reduced motion of the vessel and in this Amberdkar dock we have 4 quays, one is called as a south quay. This is west quay, this is north quay and this one is the east quay. Quay consists of if we see this west quay along the west quay we have many berths. The berths are (19:49) here along the south quay also we have two berths and there is a entrance to Jawahar dock and the Bharathi dock the water depth is more. The water depth varies from 14 meters here upto 17 meters in the iron ore berth and oil berth, we have two oil berths here oil berth Bharathi dock one and Bharathi dock 2. These are the two oil berths and this is the iron ore berth. This is your container berth. It is called as the first container berth. This also has gone in PPP mode DP old is (20:33) operating as a partner for this container berth. This length is about a kilometer and I want to further extend this along this line so that we will have a long berth available for containers.

Any ports needs a harbour, harbour means the break water. This is uhh called as a rubble mound break water. This is used to reduce the waves penetrating into the harbour, we have this outer arm, then we have the eastern break water, northern break water and then we have this south break water, then we will have a entrance channel. This entrance channel are used to the by the ship to come through this, just like a road marking. Roads that are developed with a sufficient width. The entrance channel is a dridgged to sufficient depth and width so that the vessels will come inside.

Suppose the width of the vessel is uhh be the entrance channel width may vary from 5 times the beam of the vessel to 7 times the beam of the vessel so that when the vessel is coming, the vessel may go something like this, it may not go along the center line to take care of that we need this. Once the vessel comes here, the vessel is uhh turn in a turning circle. The diameter of the turning circle is typically around two times the length of the vessel. The vessel is turn and berth here so that the forward end is on this side and the off-end (22:16) that is backward side is on this side. This is mainly made, because in case of emergency the vessel will directly start the engine and go out the sea that is why the vessel is (22:29).

Ship is not having any break. The ship is brought inside by tugboats and they are coming inside and normally the ship engine is stop here about 7 times the length of the ship is required for the vessel to come to a complete all as by tugboats. Tugboats are used to turn the vessel and then brought inside very close to the berth. Once the berth is once it reaches the berth, it is tied to the berthing structure and normally the vessel is also taken back by tugboats and it goes here and after (23:11) it start the engine, but in case of emergency the vessel can start the engine and go out, but any case you need tugboats for stopping the vessel as well as for tiding the vessel. Any doubt in this?

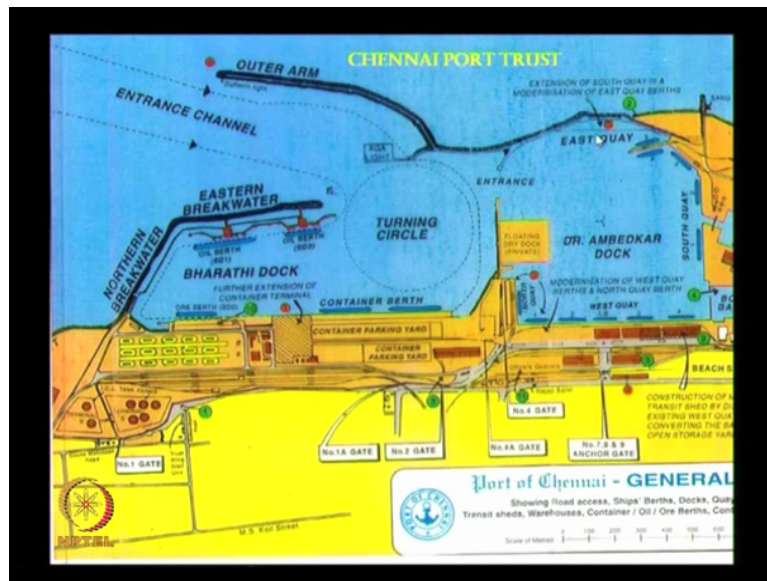
Harbour means all this components entrance channel, turning circle, break water. Port means including the harbour, the handling facilities you will have container quay cranes to load unload the cargo. We will have the loaders to load the iron ore, then we will have this marine loading arms, which are placed here to pump the oil and we may have the submarine pipelines which will be laid along this line and it goes to the store area. We have different gates that are marked here through which the cargoes can enter. This shows the scale in meters. This distance is about 800 meters. So approximately, this will be the width of the Amberdkar dock.

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Next slide will show the portion what is existing as the east quay. So I will just go back.

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So this east quay has, there was no berth, we have one berth here, which is called as finger pair. This finger pair is used for naval vessels. So they want to develop a container berth similar to this on this side so that the full length can be used for container track. They have removed this finger pair shifted the naval vessels towards this side, they have extended this uhh break water along this line, reclaim this area and they have constructed a new berth along this line for about 800 meters. This is the second container terminal.

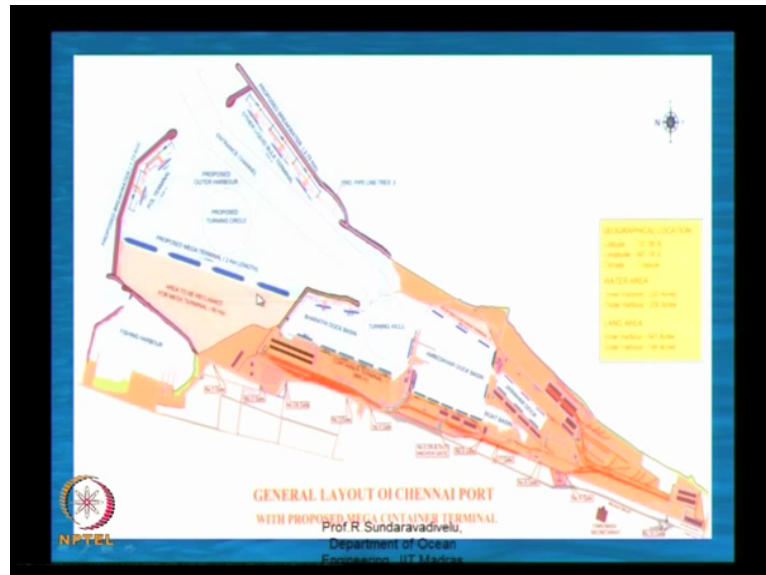
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Next slide shows the details. So this is the area where they have extended the break water. Here the filling operation is going on. They have used the sand from the (())(25:17) river and as well as from other places for filling this area and this shows the outer arm. Here the

construction of the berth is going on. There are typically 1, 2,3,4,5 rows of piles. These are called as piling and twist which are used to drive the piles. These are the equipment's, which are used for driving the pile. Once they construct the berth all along this line. They will fill up this area and then they will use this for container to be placed at this location.

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So what is required for a berth is? We need the front face and we need some area at this level at this uhh backup area for storing the containers. Any port that is being developed needs modification modernization and this is one of the modernization project, which is being carried out. Is in the planning stage what you are seeing here is the 3 docks, is called as a Jawahar dock, Amberdkar dock, Bharathi dock, entrance channel, turning circle which was exist. What they want to do is? They extend the outer arm and construct another breakwater here, one more break water here and this is the existing breakwater for the fishing harbour. This is a fishing harbour consisting of two breakwaters; the vessels will come inside for the fisherman.

So they want to construct one new breakwater like this, another breakwater like this and there is a protecting arm so that this will reduce the for a new berth oil berth, which is being planned here. This is your container berth. This is about 2 kilometer long. This is one of the major facility that will be created. This will have a draft of about 18 meter in the first face to 1construct 21 meter in the second face.

The biggest vessel is called as VLCC very large crude carrier. The very large crude carrier will come and berth here. We are planning the oil berth here, bulk berth to handle iron ore

and POL and container berth along its. This also will be developed in a PPP mode the tendering is going on. So this port once it is developed, the area will be reclaimed in this portion so that the containers what we are loading and unloading will be stacked in this area from here, it will be taken to the inland or from the inland whatever is coming will be taken out, but this uhh container berth is being developed as a transshipment berth.

Transshipment berth means we will have the min line vessel, bigger size vessel they will come from uhh abroad bigger size vessels and they will unload the cargo, from here in smaller vessels, it will be loaded into smaller vessels and will be taken to all along the coast to (( ))(28:45) Kolkata, (( ))(28:47) to neighboring countries like Bangladesh and other countries. Is it clear? Transshipment port means the main line vessel will come from point to point bigger size vessel. Bigger size vessel means up to 18000 TEU.

For 18000 TEU approximately we need about 18 meter draft. So these vessels cannot go to any other port, because we do not have any port the east coast to receive 18000 TEU vessels. It will be loaded into 4500 TEU vessel which needs about the (( ))(29:18 ) meter draft or 1000 TEU vessel needs about (( ))(29:22 ). So this is how the port is being planned. So this is called as a transshipment port. So with this we will close uhh Chennai port and we will see in the next class other ports. Thank you.