**Port and Harbour Structures.**
**Professor R. Sundaradivelu.**
**Department of Ocean Engineering.**
**Indian Institute of Technology, Madras.**
**Module-2.**
**Lecture-7.**
**Site Characteristics and Navigation Channel.**

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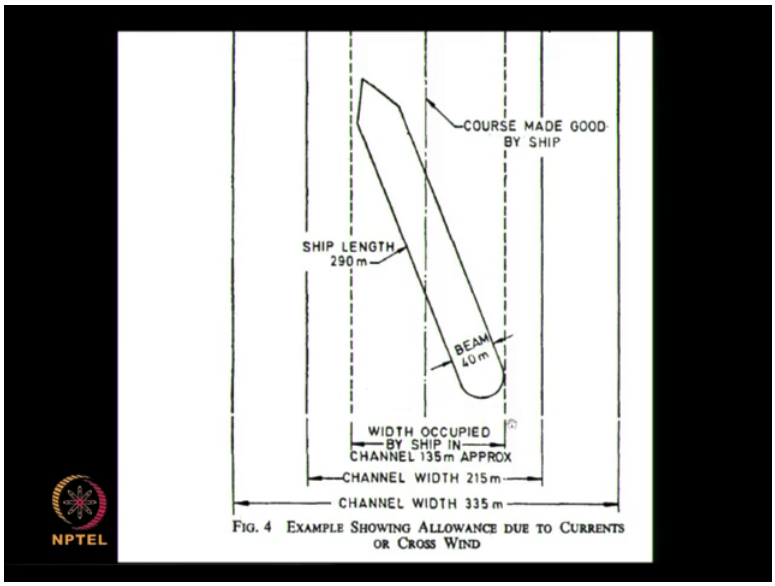

FIG. 4 EXAMPLE SHOWING ALLOWANCE DUE TO CURRENTS OR CROSS WIND

This class we will see the importance of navigation channel, this figure shows the ship and the width of channel, area is about 135 metre, here this is about 215, here it is 335 metres. Suppose there is no crosscurrents or wind, the ship will be moving in this direction, this is a course made by the good ship. Suppose there is a current in this direction, the ship will tilt towards the side and it will move like this, then we have to use the radar of the ship to make it within this. So if we have larger width there will not be any accident that will take place, if it is a smaller width like 135 metre, it is just sufficient for a vessel of 40 metre width and 290 metre length.

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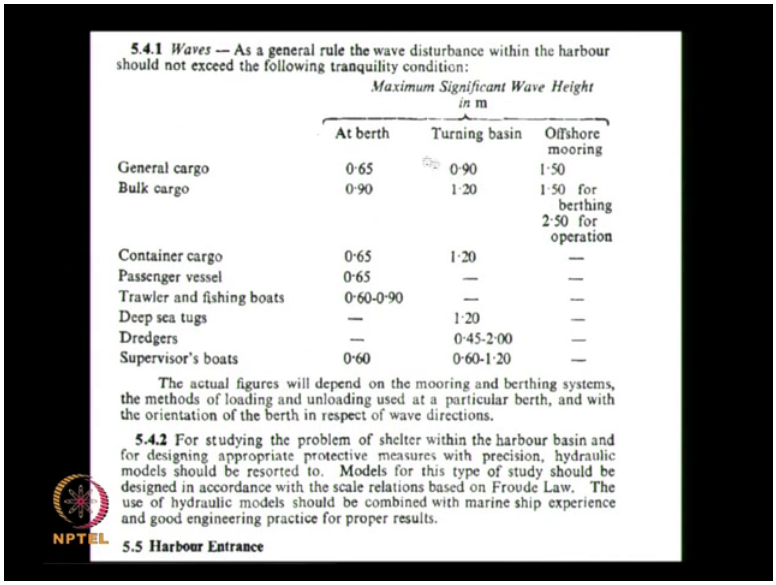


See another important thing for design of navigation channel as well as berth is what is the wave disturbance. This wave disturbance within the harbour should not extend the following tranquillity conditions. Here we call one parameter of the wave, that is the maximum significant wave height in metres, I will discuss about significant wave height in another class but to make it very simple, significant wave height is average of one 3$^{rd}$ of the highest wave heights. Suppose there are about 100 wave heights, you take top 33 wave heights and take an average, it is called as a significant wave height.

Maximum is coming because we are are taking the top 33 waves. The units are important that is in metres. So depending on the type of the vessel and the location where the vessel is, whether the vessel is that the berths, where the vessel is at the turning basin, whether vessel is at the offshore mooring, offshore mooring means in open sea conditions. There are many structures, berthing structures that are built in offshore berthing structures. In addition we have this anchorage, that is we do not have have a direct berthing port, we have anchorage port, whether vessel will be more than the offshore, then we load and unload from the offshore mooring, in small tugboats, small barges to the inside Lagoon type harbours.

So we will 1$^{st}$ discuss about general cargo, general cargo, the maximum wave height that is permissible is about 0.25 metres. Whereas in the turning basin, where the vessels turn, then it will 0.9 metres and if it is offshore mooring, it is 1.5 metres. Then if it is a bulk cargo, maximum significant wave it is 0.9 and turning basin is 1.2, 1.5 for berthing and 2.5 for operation. Then we have the container cargo, it is 0.65 metres at the berth and 1.2 metre at the turning basin.

And bulk cargo you need, you can operate at a higher wave heights, whereas containers you can operate at a lower wave height only because containers, cranes and lifting other things, generally we need smaller we need for container cargo compared to bulk cargo. Then we have trawler and fishing boats, then deep sea tugs, dredgers, supervisor boats. So summary is, in offshore mooring, generally this is for singlepoint mooring and things like that and there we can permit higher wave heights for operation. Whereas inside, where the berth is very close to the structure, any movement of vessel, any movement will create disturbance, so we need smaller wave heights.

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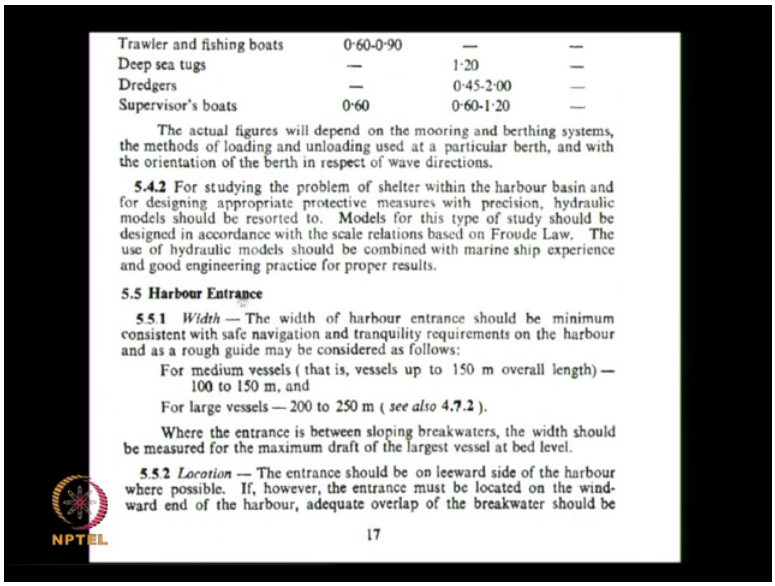


Then we have to talk about the entrance to the breakwater, entrance given by what we have to leave the gap between the breakwaters. So this is another important parameter, if we give more entrance, the vessel will ply easily but if we give more entrance, the wave heights what we are giving will be higher. So there should be a compromise between these 2 conditions. That is what it is written here, it should be minimum, consistent with safe navigation, safe navigation and tranquillity requirements. For medium vessel, that is vessel is up to 150 metres overall length, typical it is about 100 to 150 metres, for large vessels it is about 200 to 250 metres.

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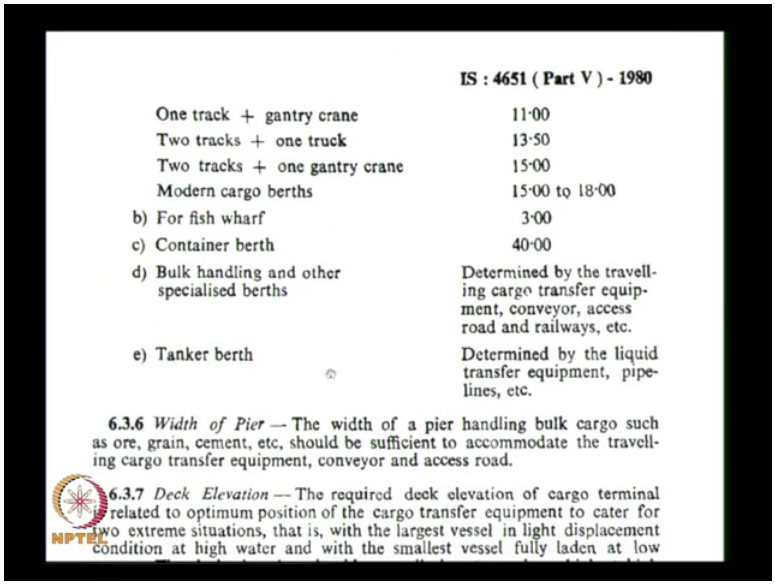


Next we will discuss about the width of the apron, apron width means the width of the berth. So the width of the berth depends on the type of cargo whether it is a general cargo and if it is one-way traffic or two-way traffic, that is a traffic on the apron, apron means the width of the platform. One-way traffic means it is 6.5, two-way traffic means 8 metres. Generally any berth cannot be less than 6.5, if you using 2 layers, to track, 2 layers, two-way traffic for loading, unloading, then you need 8 metres but if you are using one-way traffic +1 track, it should be 9.5 metres.

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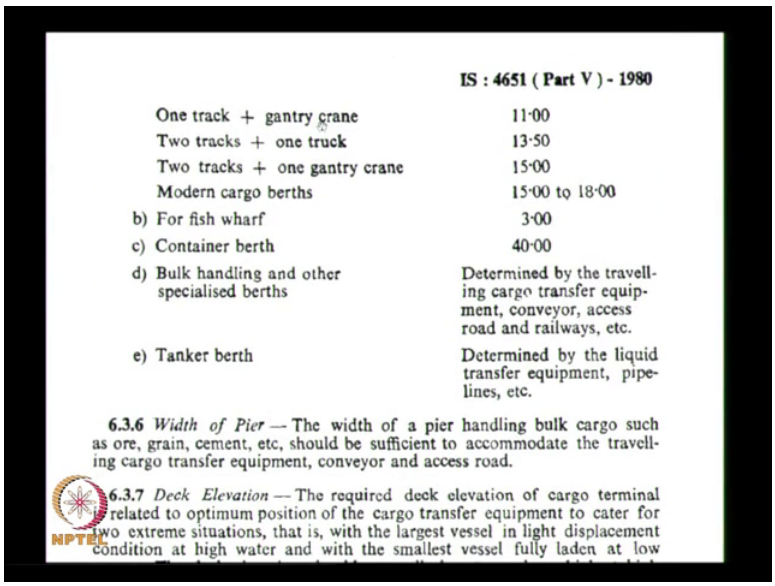


One track + gantry crane, that is the mechanical handling system, what I was telling earlier is road lines, now we have gantry crane and will have 11 metres. We have 2 trucks, 2 tracks and

one truck, 13.5, 2 tracks +1 gantry crane 15 metres, then modern cargo berths, typically differential between 15 to 18 metres. Another thumb rule is whatever is the width of the berth, we provide that as the width of the apron. But typically about this code is developed in 1980, so recent days we have berths typically between 25 metres for general cargo and bulk cargo to 40 metres for container berths.

Fisheries Harbour, it is 3 metres, container berths it is 40 metres. The bulk handling and other specialised berth depending on the cargo transfer equipment, that is rail mounted cranes, typically the rail mounted cranes, the track is about 18 metres. Here we have written gantry crane, these are small cranes where the track width is about 6 metres, it is not for bulk handling, it is for general cargo. Whether for bulk handling, it is about 18 metres, nowadays we have mobile harbour cranes which are being used, that also needs a width of about 20-25 metres.

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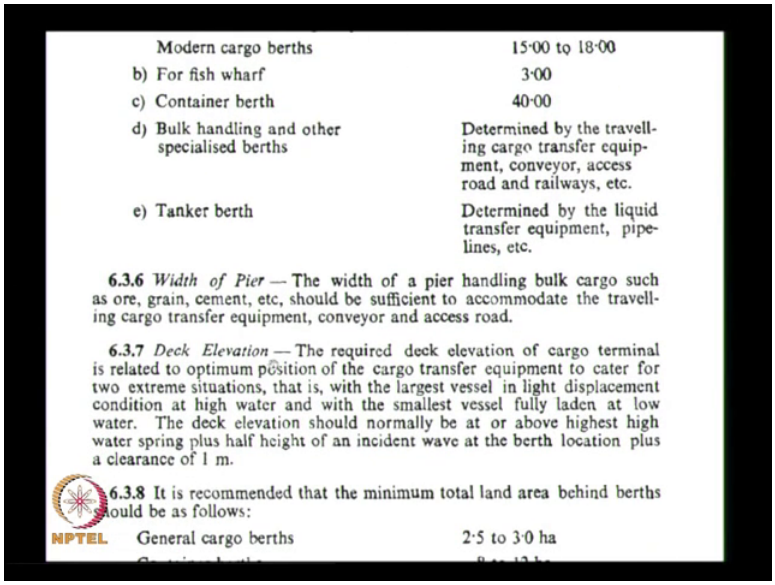


Behind the mobile harbour cranes or, I am sorry behind the gantry cranes, we will have the conveyors, so I will explain with a sketch what is the width required for this. For tanker berth it is by the Marine unloading arms what is required, that should be provided. Another important parameter is the deck elevation, deck elevation depends on various factors, but the main thing is largest vessel in light of displacement condition at high water. That is in highest high water, we have the largest water and light displacement and with smallest vessel, fully laden at low water, the deck elevation should normally be at or above highest high waters, that means + half height of an incident wave at the berth location + a clearance of 1 metre.

This deck elevation when we talk, we have to include the depth of the deck also. So that is not very clear here, so please understand that the highest high water level, + half the height of the incident wave, + 1 metre clearance + depth of the deck, we have a deck beam and deck slab, so above that you have to provide the deck elevation. So this is related to the environmental conditions, it is high water, spring, incident wave and clearance and depth of the deck, geometrical, whereas what we have discussed here is depending on the cargo transfer equipment.

So your cargo transfer equipment should be able to access the vessel in various tidal conditions, so considering that you have to fix the deck elevation. But frame consideration is this only, so than you have to make the cargo transfer equipment, according to this you have to design the cargo transfer equipment.

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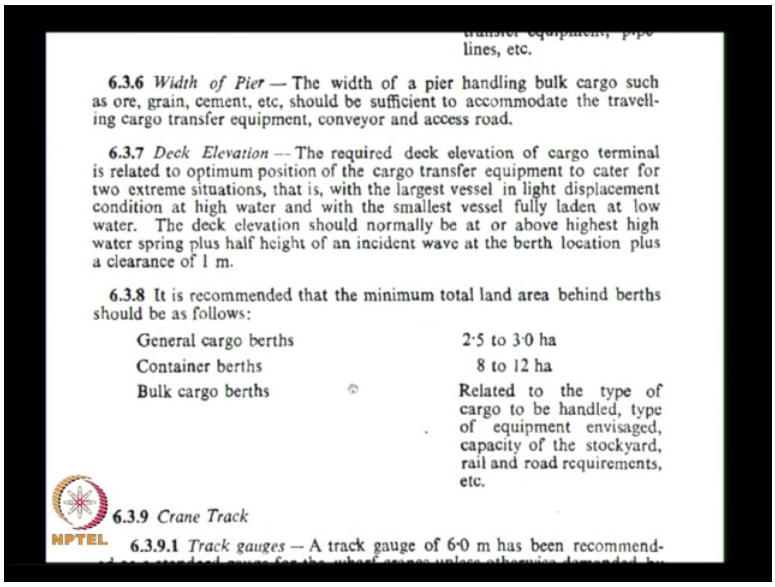
lines, etc.

**6.3.6** *Width of Pier* — The width of a pier handling bulk cargo such as ore, grain, cement, etc, should be sufficient to accommodate the travelling cargo transfer equipment, conveyor and access road.

**6.3.7** *Deck Elevation* — The required deck elevation of cargo terminal is related to optimum position of the cargo transfer equipment to cater for two extreme situations, that is, with the largest vessel in light displacement condition at high water and with the smallest vessel fully laden at low water. The deck elevation should normally be at or above highest high water spring plus half height of an incident wave at the berth location plus a clearance of 1 m.

**6.3.8** It is recommended that the minimum total land area behind berths should be as follows:

| | |
|---|---|
| General cargo berths | 2·5 to 3·0 ha |
| Container berths | 8 to 12 ha |
| Bulk cargo berths | Related to the type of cargo to be handled, type of equipment envisaged, capacity of the stockyard, rail and road requirements, etc. |

**6.3.9** *Crane Track*

**6.3.9.1** *Track gauges* — A track gauge of 6·0 m has been recommend-

Then another important parameter is what is a land area required behind the berths. So this is very important because the land space available is very less nowadays. So you have to go in for optimum spare size. Generally container berths need higher storage area compared to general cargo and this is given as 2.5 to 3 hectares and 8 to 12 hectares. Here we have not written anything about the capacity of the berths but generally the general cargo of the berths is about 200 million tonnes and this will be about container berths, 300 metre container berths will handle 300 metres into 1500, that is about 300 into 1500 is how much is about 4. I think 45,000 TEOs.

So that is what we have to cater for. Then bulk cargo berths, it depends on the equipment handling and other things. If you want to see in terms of 1 million tonnes of cargo to be handled, we need about 2.5 to 3 actors, that is what is required for a general cargo berths. If the cargo handling is fertiliser and things like that, then you have to go even up to 8 hectares. Whereas, for bulk cargo berths, if we have efficient handling, it can reduce from 1 million tonnes to about 1.5 hectares. And for 1 million TEOs to be handled, we need about 40 hectares.

Earlier I said 45,000, I think it is 4.5 lakhs, so 1 million TEOs if we want to handle, we need about 40 characters. In foreign countries they have only 25 hectares for 1 million TEOs. So what I am trying to say is in terms of tonnes for cargo to be handled. This is very already discussed what is the track gauge, this is 6 metres, this is the standard gauge.

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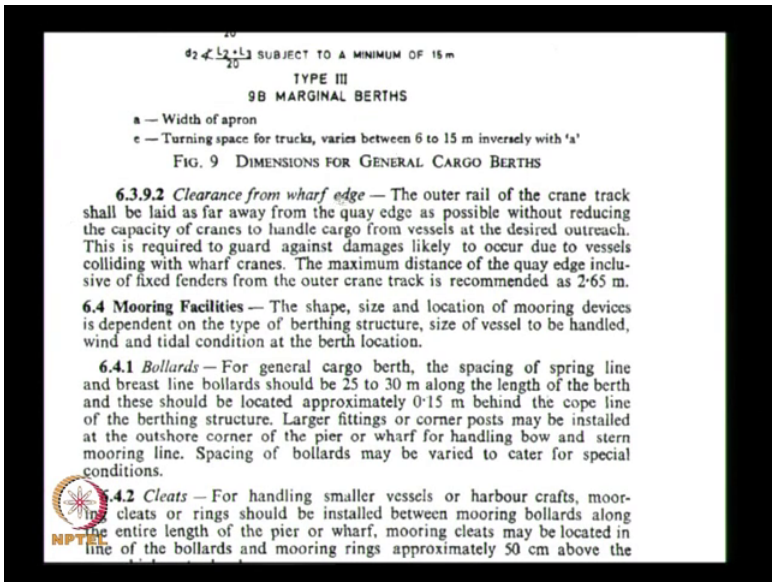

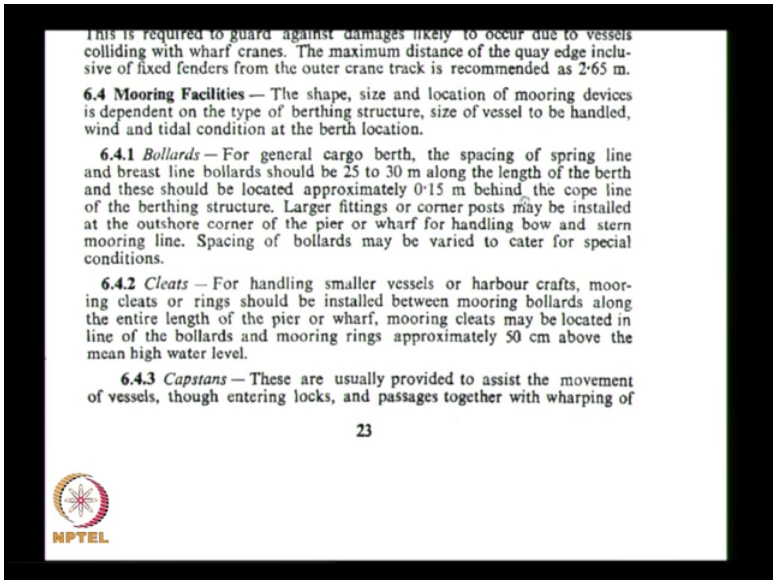

This is required to guard against damages likely to occur due to vessels colliding with wharf cranes. The maximum distance of the quay edge inclusive of fixed fenders from the outer crane track is recommended as 2·65 m.

**6.4 Mooring Facilities** — The shape, size and location of mooring devices is dependent on the type of berthing structure, size of vessel to be handled, wind and tidal condition at the berth location.

**6.4.1** *Bollards* — For general cargo berth, the spacing of spring line and breast line bollards should be 25 to 30 m along the length of the berth and these should be located approximately 0·15 m behind the cope line of the berthing structure. Larger fittings or corner posts may be installed at the outshore corner of the pier or wharf for handling bow and stern mooring line. Spacing of bollards may be varied to cater for special conditions.

**6.4.2** *Cleats* — For handling smaller vessels or harbour crafts, mooring cleats or rings should be installed between mooring bollards along the entire length of the pier or wharf, mooring cleats may be located in line of the bollards and mooring rings approximately 50 cm above the mean high water level.

**6.4.3** *Capstans* — These are usually provided to assist the movement of vessels, though entering locks, and passages together with wharping of

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See another important thing is, there are 2 rails for the crane, one rail is on the seaside, another rail on the land side. We call what is called as key edge, key edge means the face of the berth, maximum distance of the key edge including, inclusive of fixed fenders from the outer crane track is recommended as 2.65 metres. This is what they have given, but the minimum distance also should be of this order only, because otherwise the vessel will hit the crane. So this 2.65 metres, they have given maximum distance, but the maximum distance is nowadays increased, it is even up to 3-3.5 metres they are giving but minimum distance should be about 2.65 metres.

Then about, this is about the fixing of the rail on the berths, other things are about the mooring facilities. We have 3 mooring facilities that are described here, one is the bollard, another is the cleat, the 3$^{rd}$ one is the capstans. We should know what should be the spacing of the Bollard, that is at every 25 to 30 metre along the length of the button they should be located approximately 0.15 metres behind the cope line of the berthing structure. Cope line means the face of the berth, so it should be located very close to the berth, about 0.15 metre, the spacing of Bollard is about 25 to 30 metres. The cleat is for smaller vessels and capstan is the one which is used in radars and other places to assist the movement of the vessel.

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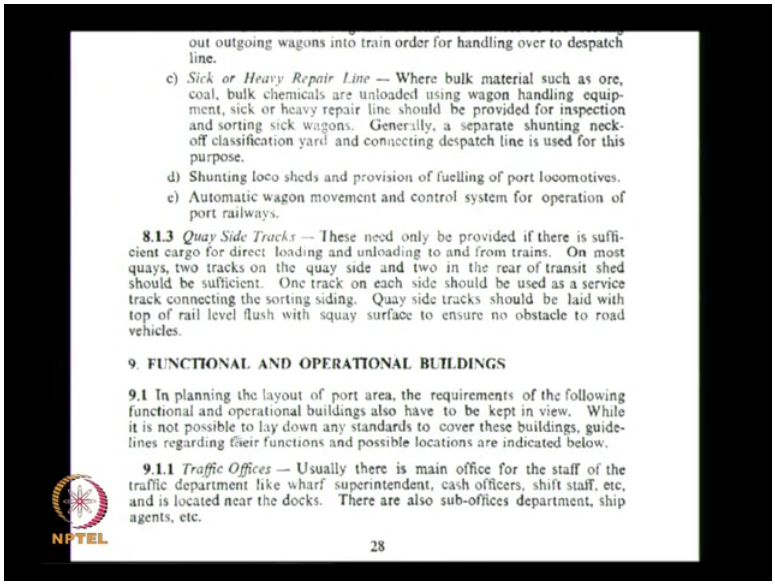


out outgoing wagons into train order for handling over to despatch line.

c) *Sick or Heavy Repair Line* — Where bulk material such as ore, coal, bulk chemicals are unloaded using wagon handling equipment, sick or heavy repair line should be provided for inspection and sorting sick wagons. Generally, a separate shunting neck-off classification yard and connecting despatch line is used for this purpose.

d) Shunting loco sheds and provision of fuelling of port locomotives.

e) Automatic wagon movement and control system for operation of port railways.

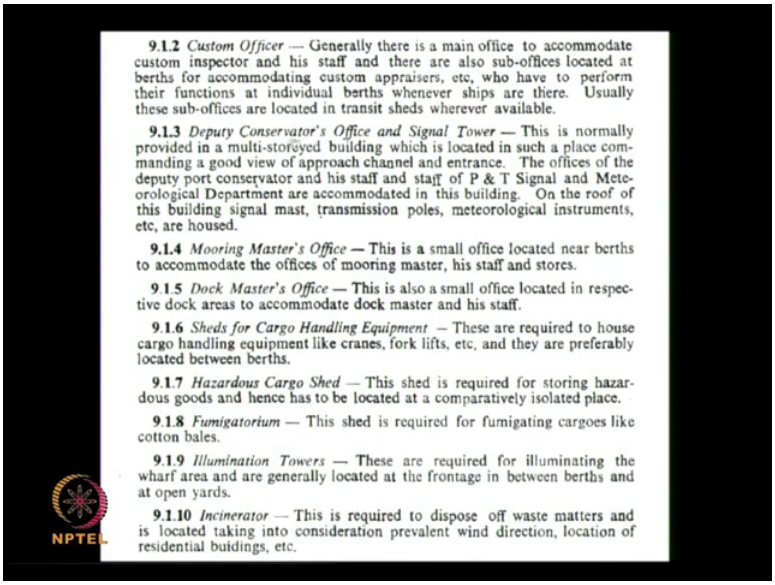
**8.1.3** *Quay Side Tracks* — These need only be provided if there is sufficient cargo for direct loading and unloading to and from trains. On most quays, two tracks on the quay side and two in the rear of transit shed should be sufficient. One track on each side should be used as a service track connecting the sorting siding. Quay side tracks should be laid with top of rail level flush with squay surface to ensure no obstacle to road vehicles.

## 9. FUNCTIONAL AND OPERATIONAL BUILDINGS

**9.1** In planning the layout of port area, the requirements of the following functional and operational buildings also have to be kept in view. While it is not possible to lay down any standards to cover these buildings, guidelines regarding their functions and possible locations are indicated below.

**9.1.1** *Traffic Offices* — Usually there is main office for the staff of the traffic department like wharf superintendent, cash officers, shift staff, etc, and is located near the docks. There are also sub-offices department, ship agents, etc.





**9.1.2** *Custom Officer* — Generally there is a main office to accommodate custom inspector and his staff and there are also sub-offices located at berths for accommodating custom appraisers, etc, who have to perform their functions at individual berths whenever ships are there. Usually these sub-offices are located in transit sheds wherever available.

**9.1.3** *Deputy Conservator's Office and Signal Tower* — This is normally provided in a multi-storeyed building which is located in such a place commanding a good view of approach channel and entrance. The offices of the deputy port conservator and his staff and staff of P & T Signal and Meteorological Department are accommodated in this building. On the roof of this building signal mast, transmission poles, meteorological instruments, etc, are housed.

**9.1.4** *Mooring Master's Office* — This is a small office located near berths to accommodate the offices of mooring master, his staff and stores.

**9.1.5** *Dock Master's Office* — This is also a small office located in respective dock areas to accommodate dock master and his staff.

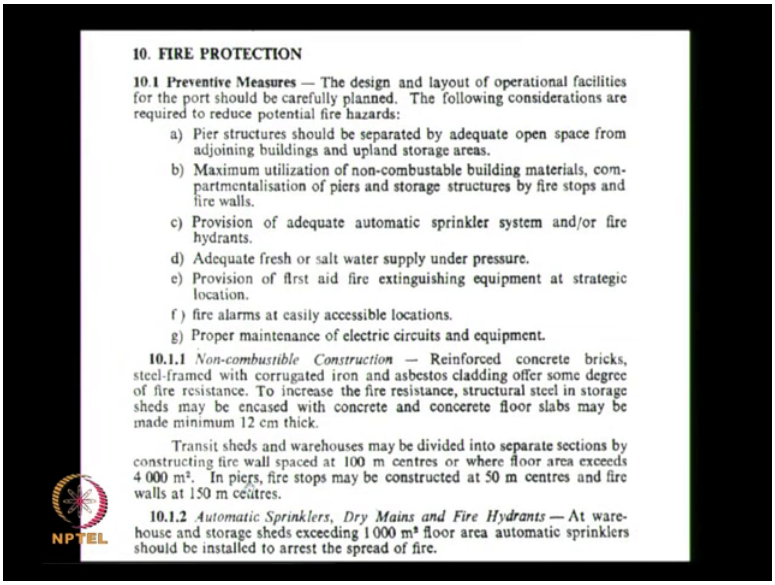
**9.1.6** *Sheds for Cargo Handling Equipment* — These are required to house cargo handling equipment like cranes, fork lifts, etc, and they are preferably located between berths.

**9.1.7** *Hazardous Cargo Shed* — This shed is required for storing hazardous goods and hence has to be located at a comparatively isolated place.

**9.1.8** *Fumigatorium* — This shed is required for fumigating cargoes like cotton bales.

**9.1.9** *Illumination Towers* — These are required for illuminating the wharf area and are generally located at the frontage in between berths and at open yards.

**9.1.10** *Incinerator* — This is required to dispose off waste matters and is located taking into consideration prevalent wind direction, location of residential buildings, etc.



## 10. FIRE PROTECTION

**10.1 Preventive Measures** — The design and layout of operational facilities for the port should be carefully planned. The following considerations are required to reduce potential fire hazards:

a) Pier structures should be separated by adequate open space from adjoining buildings and upland storage areas.

b) Maximum utilization of non-combustable building materials, compartmentalisation of piers and storage structures by fire stops and fire walls.

c) Provision of adequate automatic sprinkler system and/or fire hydrants.

d) Adequate fresh or salt water supply under pressure.

e) Provision of first aid fire extinguishing equipment at strategic location.

f) fire alarms at easily accessible locations.

g) Proper maintenance of electric circuits and equipment.

**10.1.1** *Non-combustible Construction* — Reinforced concrete bricks, steel-framed with corrugated iron and asbestos cladding offer some degree of fire resistance. To increase the fire resistance, structural steel in storage sheds may be encased with concrete and concerete floor slabs may be made minimum 12 cm thick.

Transit sheds and warehouses may be divided into separate sections by constructing fire wall spaced at 100 m centres or where floor area exceeds 4 000 $m^2$. In piers, fire stops may be constructed at 50 m centres and fire walls at 150 m centres.

**10.1.2** *Automatic Sprinklers, Dry Mains and Fire Hydrants* — At warehouse and storage sheds exceeding 1 000 $m^3$ floor area automatic sprinklers should be installed to arrest the spread of fire.

So when you want to plan to complete, just run through this functional and operational buildings, so we will have traffic officers, we will have custom officers, deputy Conservative officers and signal tower. The signal tower is very important, this is a navigation tower which controls all the vessels which are coming in and going out. You know about this air traffic controller, like that we have a signal tower. Mooring masters office, Dock masters office, sheds for cargo handling equipments, hazardous cargo shed, fumigatorium, it is to fumigate the cargoes like cotton bales and all. Illumination towers, incinerators, these are transit sheds, warehouses, the fire stations, this also very important. So these are some of the buildings that have to be provided.

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**DIMENSIONS OF BERTHS**

| TONNAGE | DEPTH OF WATER AT BERTH m | LENGTH OF BERTH m |
|---|---|---|
| a) *Passenger Ships ( GRT )* | | |
| 500 | 4·5 | 65 |
| 1 000 | 5·0 | 80 |
| 2 000 | 5·0 | 100 |
| 3 000 | 6·5 | 115 |
| 4 000 | 7·0 | 125 |
| 5 000 | 7·5 | 135 |
| 6 000 | 8·0 | 145 |
| 7 000 | 8·5 | 150 |
| 8 000 | 8·5 | 155 |
| 10 000 | 9·0 | 170 |
| 15 000 | 9·5 | 190 |
| 20 000 | 10·0 | 210 |
| 30 000 | 11·0 | 240 |
| 50 000 | 11·5 | 275 |
| 80 000 | 13·0 | 320 |

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So there is a very exhaustive fire protection requirements, this also has to be provided inside the harbour. Now we are coming to the end of this port planning. So in this appendix, it is giving, this table gives what will be the size of the vessel, that is in terms of GRT, what is the depth required and what is the length of the berth. So this gives an idea, since we have a passenger ship of different sizes, what will be the water depth required and what is the length of the berths.

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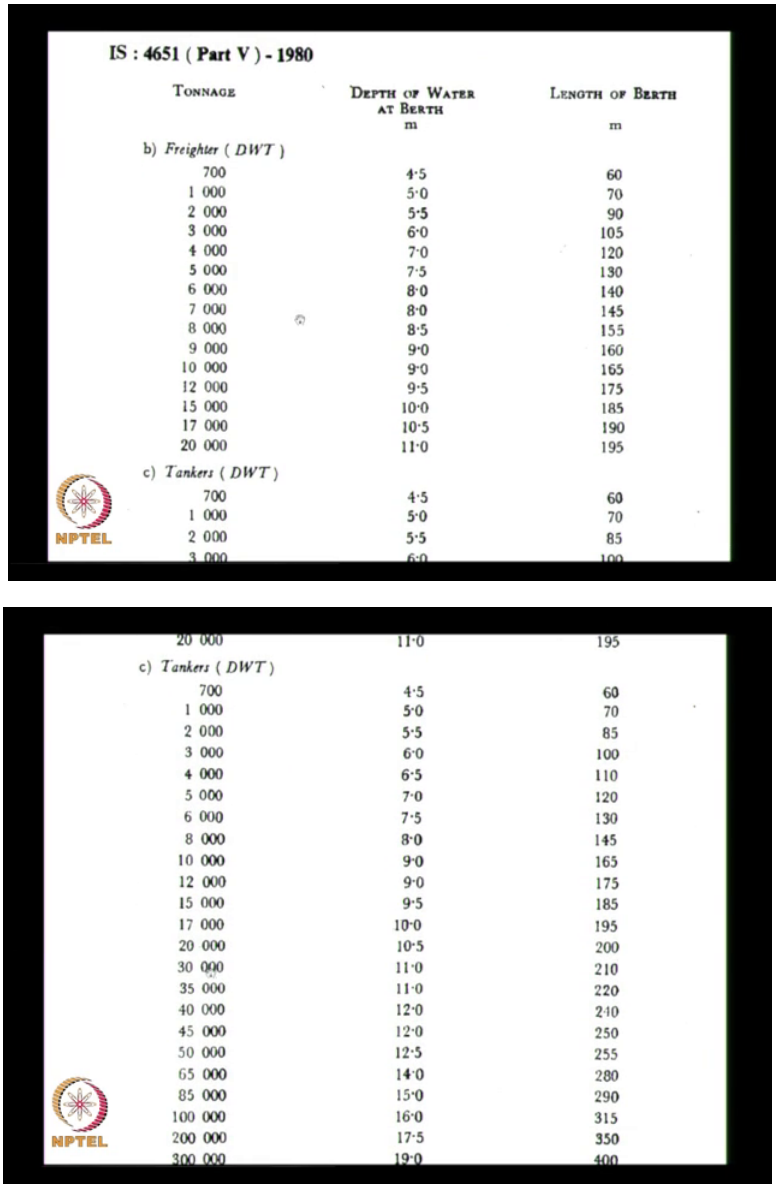

IS : 4651 ( Part V ) - 1980

| Tonnage | Depth of Water at Berth m | Length of Berth m |
|---|---|---|
| b) *Freighter ( DWT )* | | |
| 700 | 4·5 | 60 |
| 1 000 | 5·0 | 70 |
| 2 000 | 5·5 | 90 |
| 3 000 | 6·0 | 105 |
| 4 000 | 7·0 | 120 |
| 5 000 | 7·5 | 130 |
| 6 000 | 8·0 | 140 |
| 7 000 | 8·0 | 145 |
| 8 000 | 8·5 | 155 |
| 9 000 | 9·0 | 160 |
| 10 000 | 9·0 | 165 |
| 12 000 | 9·5 | 175 |
| 15 000 | 10·0 | 185 |
| 17 000 | 10·5 | 190 |
| 20 000 | 11·0 | 195 |
| c) *Tankers ( DWT )* | | |
| 700 | 4·5 | 60 |
| 1 000 | 5·0 | 70 |
| 2 000 | 5·5 | 85 |
| 3 000 | 6·0 | 100 |



| | | |
|---|---|---|
| 20 000 | 11·0 | 195 |
| c) *Tankers ( DWT )* | | |
| 700 | 4·5 | 60 |
| 1 000 | 5·0 | 70 |
| 2 000 | 5·5 | 85 |
| 3 000 | 6·0 | 100 |
| 4 000 | 6·5 | 110 |
| 5 000 | 7·0 | 120 |
| 6 000 | 7·5 | 130 |
| 8 000 | 8·0 | 145 |
| 10 000 | 9·0 | 165 |
| 12 000 | 9·0 | 175 |
| 15 000 | 9·5 | 185 |
| 17 000 | 10·0 | 195 |
| 20 000 | 10·5 | 200 |
| 30 000 | 11·0 | 210 |
| 35 000 | 11·0 | 220 |
| 40 000 | 12·0 | 240 |
| 45 000 | 12·0 | 250 |
| 50 000 | 12·5 | 255 |
| 65 000 | 14·0 | 280 |
| 85 000 | 15·0 | 290 |
| 100 000 | 16·0 | 315 |
| 200 000 | 17·5 | 350 |
| 300 000 | 19·0 | 400 |

Similarly it is given for freighters, then tankers. So for example if we take a 30,000 DWT, the depth required is 11 metres. The depth is different from the draft, the draft is 9 metre, typically 9 to 9.5 metres, depth is 11 metres, the length required is about 210 metres. So for 300,000 DWT vessel, depth required is 19 metres, the length required is 14 metres. So I earlier shown in one of the lectures what is the size of the vessel, but now what I am giving a what is the water depth required and what is the length of the berth. For Ore carriers, for about 80,000 DWT which is more economical nowadays, water depth required is 13.5, length required is 290 metres.

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This is only the guideline, so we will go to next lecture, next lecture is on surveys, so this survey is very important, before you do any construction activities, you have to carry out the survey. And the main focus of the berthing structure course is estimation of load, analysis and design, but to estimate the load we need to get some of the characteristics. Can you tell me what all the site characteristics you need, what are the surveys we have to do, what are the parameters you require? You want to say something, what is that?

Area.

Area means what, what is it that you have to do? Survey means, what all surveys you know? Civil engineering students must be knowing. You know about topographicc survey? What is topographic survey? Civil engineering students, you are doing some survey on the roads and all, you have completed, what is it you are trying to find out with that? What is that you are trying to find out when you do the survey? Who are all civil engineer students, you have done the survey no?

Contours.

So you try to find out the levels at various points. That is called as the topography survey. Similar thing if we do it in the sea, it is called as the bathymetric survey, okay. When you want to plan a harbour from the seaside, ocean engineering students, what are all the information you need? We are putting a structure the sea, what all the sea parameters you have to find out?

Slope of the bottom.

What is it, slope of the bottom. That is bathymetric survey, bathymetric survey will give the seabed slope. What else?

Tidal variations.

How will you get the tidal variations?

Tide table is there.

Tide table is there but this is site, if we go to the site and we want to find out the tide. We have an instrument called tide gauge, you place the instrument and measure the water level continuously and find out what is the tidal variations. What other parameters are required? Other students also can reply because I have said so many parameters to affect the design of the structure. ?

Wave heights.

So we have to measure the waves. How to measure the waves? ?

By pressure transducer.

Pressure transducer or we have what is known as the wave data buoy. So we deploy a buoy in the sea and measure the waves. What are the other parameters? Tide, wave, one more important parameter is there, current, you have to find current also. Current means you to measure both current velocity and direction. That is also there, you have a current metre. What is another parameter if you are trying to design a structure? Building… Wind you have to measure, you have to deploy a wind and then you have to measure. What other parameters are required? You want to design a building, what is the important parameter required?

Soil investigation.

So this in summary the various study that are to be carried out. Soil investigation is required. Soil investigation not only on the land, you have to investigate the soil on the sea also. You have to deploy in the sea and carry out the investigation. In addition we get other parameters like temperature, salinity, so many other things.

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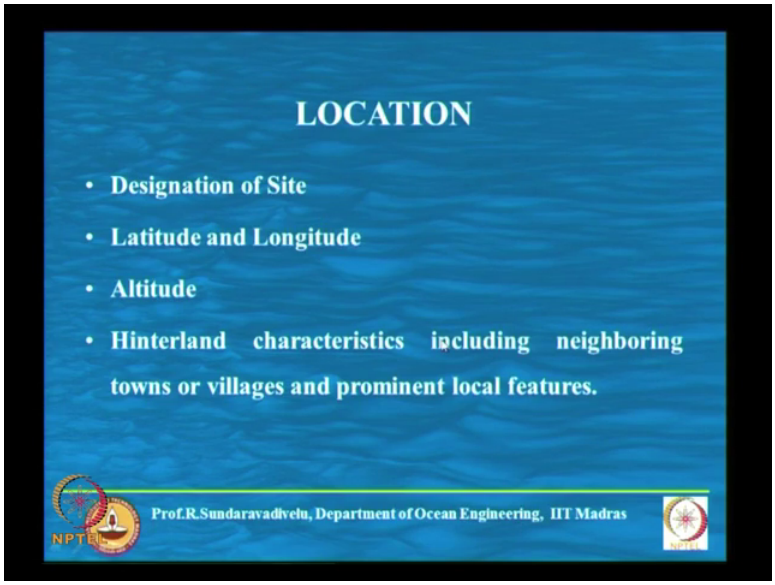


So 1st we will see about the location, so we have to designate the site. So this is important, we have to have the designation of the site, just like everybody has a name, we give the name for the site. Earlier there was a lot of problems when you had the railway stations named after the political leaders and other things. So now most of the railway stations are named with the location, the village name, the existing village. You cannot create a new name for the village and give it, whatever is the village, you have to give.

We have a Fort at Gopalpur, the location, there is a smalltown nearby is Gopalpur, you designate the site as Gopalpur. We need this Latitude and longitude also, then altered also. Latitude, longitude means, I will explain with a figure, otherwise these are the 2 coordinates which will give the location, altitude means it is the height. Then we should get the hinterland characteristics including neighbouring towns or villages and prominent local features. Local features means it can be there is a hill, there is a lake a mother is a River, there is a heritage site, all these things you have to see.

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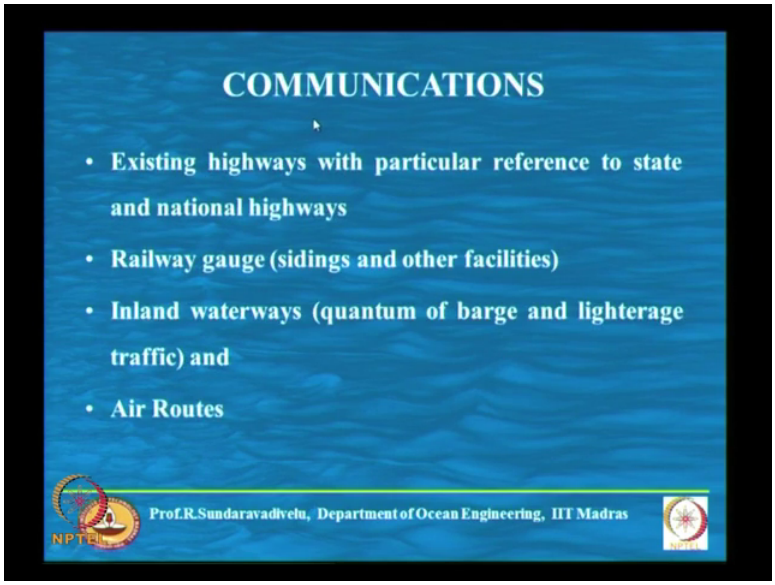


The next, 1st it is the location, then the communication. Communication means what are all the existing highways with particular reference to state and national highways. This is very important because during construction, even before construction, even to carry out the survey, somebody has to go to that location, he needs to know what is the existing communication facilities. Railway gauges, sidings and other facilities. So railway lines, we provide a siding to many ports, so there is a separate line going, that you have to give.

Then inland waterways, quantum of barge and light range traffic and air routes. So air-traffic is also important because whenever you develop a port, the consultants, either from India or abroad, they have to come to the site, so they may be coming by air, so this is also required. So these highways, rail and waterways are required for transport of cargo once the port is commissioned and the air route also is required because sometimes some specific equipment required for firefighting or something, it has to be air transported.

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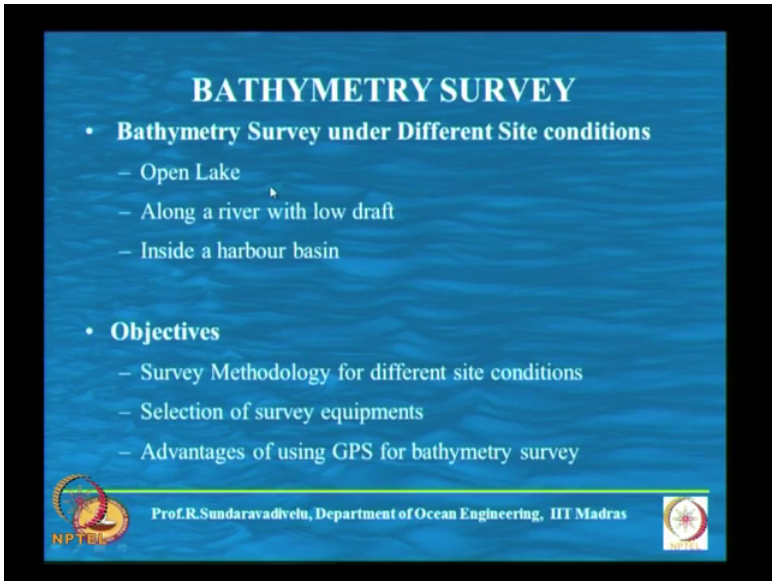


Apart from that location and communication, we now go into the technical requirements, it is a bathymetric survey. It will be done for different site conditions, it can be on open Lake or on a River, or inside a harbour basin. So each case the bathymetric survey is slightly different. Survey methodology for different site conditions, selection of survey equipments and there are some advantages using this GPS for bathymetric survey, that also we will discuss.

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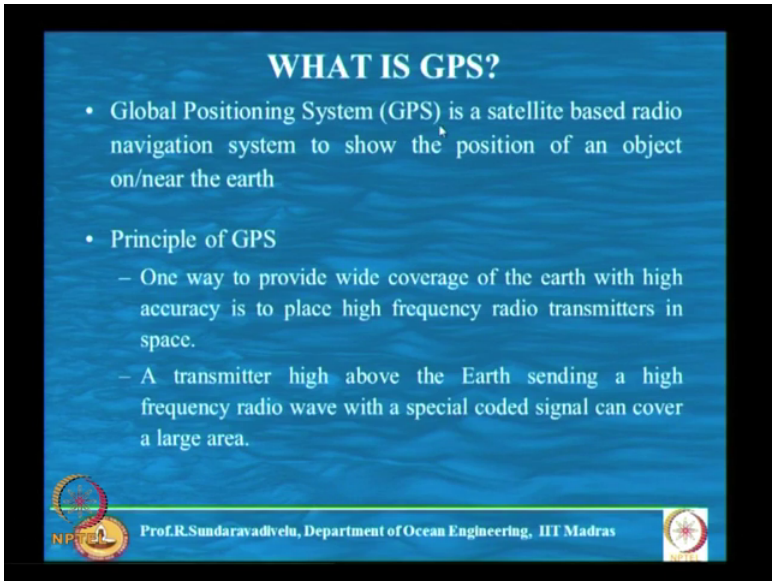


Now we will see what this GPS. GPS is a satellite-based radio navigation system to show the position of an object on or near the Earth. Nowadays the cell phone also has GPS, you can find out but what is required in GPS, when you go for a survey is actually see. The accuracy

requirement varies, if it is a handheld GPS, accuracy maybe about 10 metres. If we take the GPS today, it shows some Latitude-longitude, then after sometime the same location you may not get the same Latitude-longitude.

So you have to move maybe about 5 metres or 10 metre to get the same Latitude and longitude. But we have differential GPS which is having very high accuracy, they claim it is up to 1 metre. So once you have this high accuracy GPS, then your position fixing is very good. So it is, the principal of GPS is given, it is to place high-frequency radio transmitters in space. A transmitter high above the earth sending a high-frequency radio wave with a special coded system can cover a large area. The differential GPS or good GPS survey, we get the signal at least from 3 satellites, not from single satellite.

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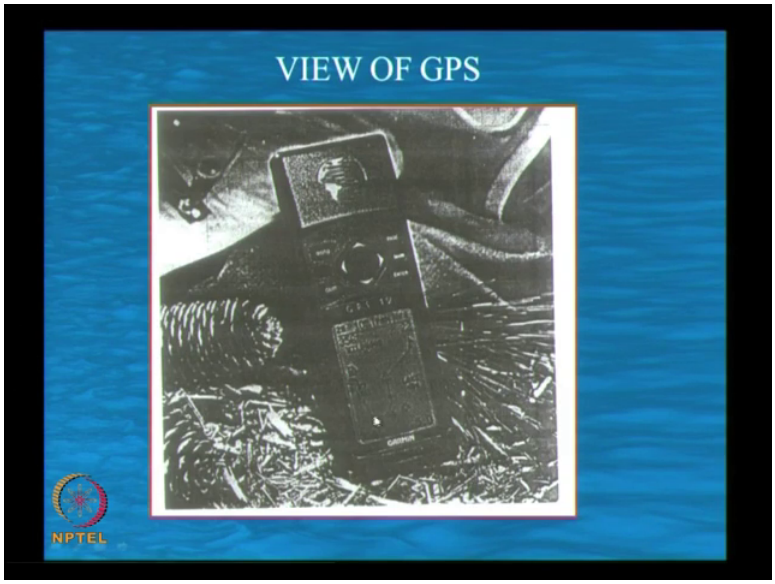


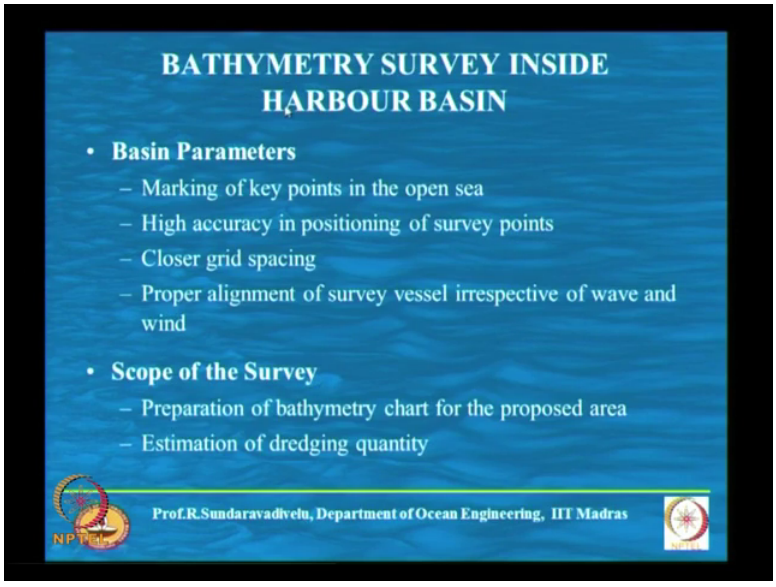

You have a base station and you have a ground route data to cover this. This shows the photograph of a handheld GPS. Whenever we go for any site visit, we carry the GPS along with us, this is one of the essential equipments with which we will go. So there is various requirements for the survey. When you do your bathymetric survey inside the harbour basin, what is shown here is not at the planning stage but to the maintenance, dredging and other things, at that time the harbour basin is well established, so you make key points on the open sea.

To spend some more time on this, there are 2 types of bathymetric survey required, one survey is required once the port is commissioned, another survey is required for the greenfield airport when we have to do the survey. I have some examples which I will show you later. So once you establish a port and you want to do a survey in a harbour basin, you have to mark key points in the open sea, the high accuracy is required in the positioning of the survey points, you need closer grid spacing.

Grid spacing means what it value have to find out the depth, it is, to be simple bathymetric survey means you have to find out the water depth at different locations. Can you tell me how close we want to get the water depth? Yes? What will be the size of harbour basin approximately? Typically about 1500 by 2000 metres is normally the size of the harbour basin, 1500 by 2000 metres. How close you have to measure water depth? You can get it from the standard textbooks, but you please think about it. How close?

50 metres.

50, then any other answer? 50 metres is very close to the answer but normally what they do is they have some transects every 100 metre of something like that, great lines. But each grid line they make very close spacing, 25 metres and think like that. It is not uniform, uniform also is okay, you can do it. Then we use for survey vessel, then proper alignment of survey vessel irrespective of wave and windage is important. That is, you go through the grid, what I am saying is every 100 metre you have a grid, the vessel has to move in a grid of 100 meters, it has to go along those lines, so those lines, it will go properly.

The scope of the survey, what is the scope, it is the preparation of bathymetry chart for the proposed area and estimation of dredging quantity. This is the maintenance dredging quantity, what we normally do is we prepare the bathymetry, find out the water depth and see whether

the water depth is as per the requirement, if not you have to find out how much soil has to be dredged, for that purpose this will be used.

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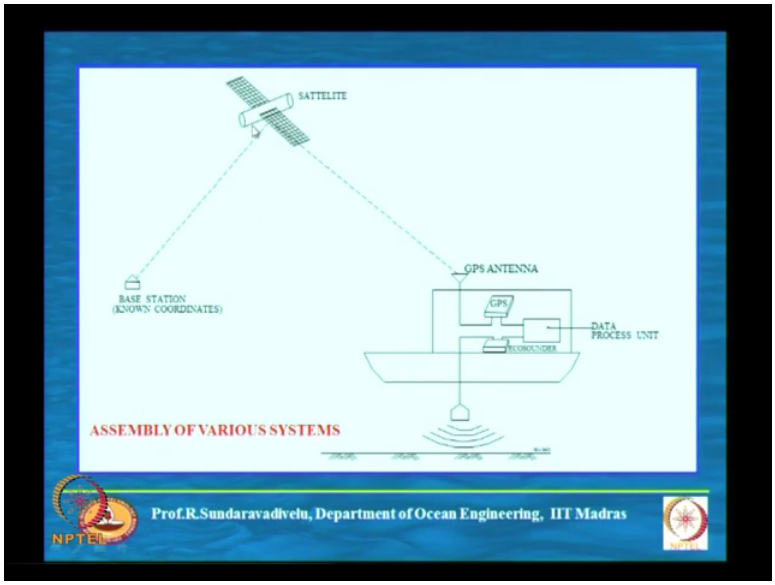


So this is the base station, this is the satellite, this is a vessel, this is the GPS antenna, there is a sounding equipment. So this can be, different types are there. It is acoustic transducer only, various types are there, that we will see, one is called as echo sounder, another is called as the sounding rod. So this sketch explains the vessel is moving in water, water line is not marked here, there is a seabed here, this is the GPS, that is having an antenna, it receives the signal from the satellite, base station also receives the signal from the satellite, so this is called as the differential transducer.

We have 2 GPS, one on the base station, that is on the land, another on the vessel, it receives the signal from the same satellite, then matches the signal, make any corrections required for the position, then you have any echo sounder which is deployed below the vessel, it sends acoustic signals from the seabed it receives back and find out the water depth at a particular location. All this data is stored in the data process unit. Though it looks simple, there are certain problems are associated with that, some corrections are to be made.

When the vessel is moving, a vessel will have some acceleration, so we need to have what is known as the heave compensation. Heave means the motion of the vessel in the particle direction, it is called as the heave, a vessel can also pitch and it can also roll, that is the, there are 3 translation motions, that is the heave vertical motion, surge and sway is perpendicular to the stream. So 3 translation and 3 rotational motions, one is called as the pitch, rotation in this

direction, another is yaw on the plane of the water, another is the roll motion, perpendicular to this.

So 6 motions will be there, generally we have to give only for heave compensation. Another is the tidal level will vary, throughout the survey period that also you have to make some corrections. That there is some sensitivity of the equipments, anything less than 2-3 metres, the echo sounder will not work I this has some physical, I am sorry, what is that equipment for the echo sounder which will be deployed below will have some dimensions. So this is a, very close to the seabed you will not get the signal. So minimum water depth it can measure below the vessel bottom is about 2 to 3 metres only, I am sorry, less than 2 to 3 metres this will not measure, more than 2 to 3 metres only it will measure.

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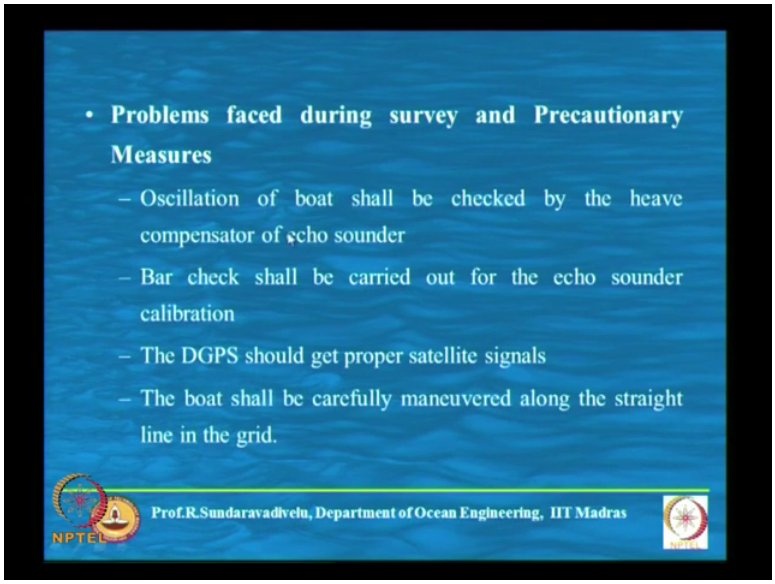


So what are the problems faced during survey and precautionary measures. Oscillation of boat shall be checked by the heave compensation of echo sounder, bar check should be carried out for the echo sounder calibration, this is important, you have to do the calibration. The DGPS should get proper satellite signals, the boat shall be carefully manoeuvred along the straight line in the grid, these are the various factors that are required.

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This shows the bathymetric Chart prepared and given by naval hydrographic chart. This is Bombay and here we have this Elephanta Island and this is the place for JNPT, this is a navigation channel, it goes through this. So survey we have to carry out both in the navigation channel, as well as in the turning circle. Here we have the harbour, Mumbai harbour is on this side, this is the Arabian Sea, this is North, this is on the western side and we have the Bombay harbour protected by the Bombay Island from the Arabian Sea.

And JNPT is well protected, we have the Elephanta Island that is also protecting and in addition the whole Bombay Island is protecting the JNPT, you have the navigation channel here. So you have to do the survey at very close interval at these locations. Then scale is also important, what scale you prepare the survey.

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This shows Chennai, this is your Jawahar Dock, this is your Ambedkar Dock, this is your Baradi Dock, this is your entrance channel, this is your turning circle. I was talking about harbour basin, this is the outer harbour basin, this is inner harbour basin, this is the breakwater, this is true North and this is your eastern side and here you have the fisheries harbour which is located here. So this shows the contour lines, bathymetric contour lines. What is shown here, this is the water depth, it is marked here and this is your navigation channel, this is your turning circle.

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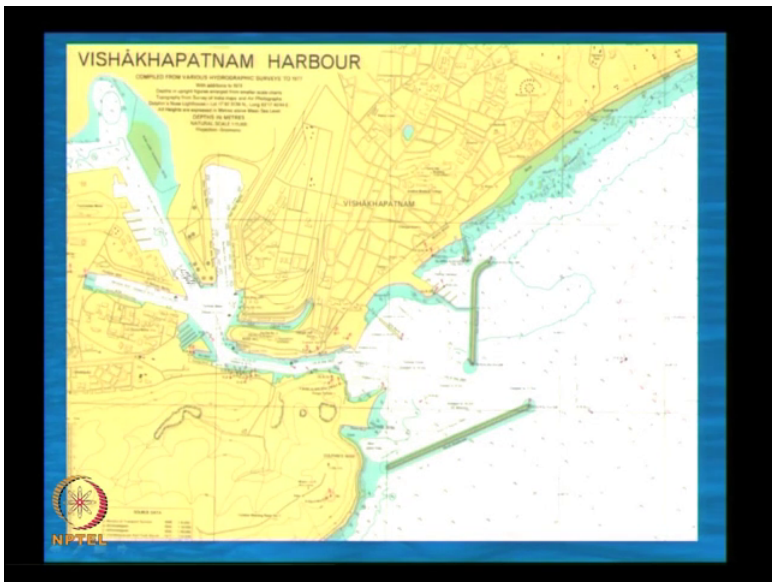


It shows the layout for Visakhapatnam harbour, both inner harbours, turning circle, entrance channel for the inner harbour and the outer harbour, breakwaters, fisheries harbour. This

contour, I think most probably this must be about 10 metre contour that is marked here. Here we have the opening at the shore connected breakwater, so there is a sand track here, there is an entrance earlier, this is the turning circle.

So this, I think now you know what is the importance of the bathymetry survey, that is you have to prepare the survey and give it to the ship master so that he knows where the water depth is, required water depth is available. I think last week there is a capsizing of a This passenger Queens vessel no. All of you are aware, have you seen the newspaper? What is the reason for the failure? Accident? It hit some rocky patch, they are telling so many reasons but one of the reasons is it had got to a place where sufficient water depth is not available and it is moving to a place where the sufficient water depth is not available, it will come and hit, that is what has happened.

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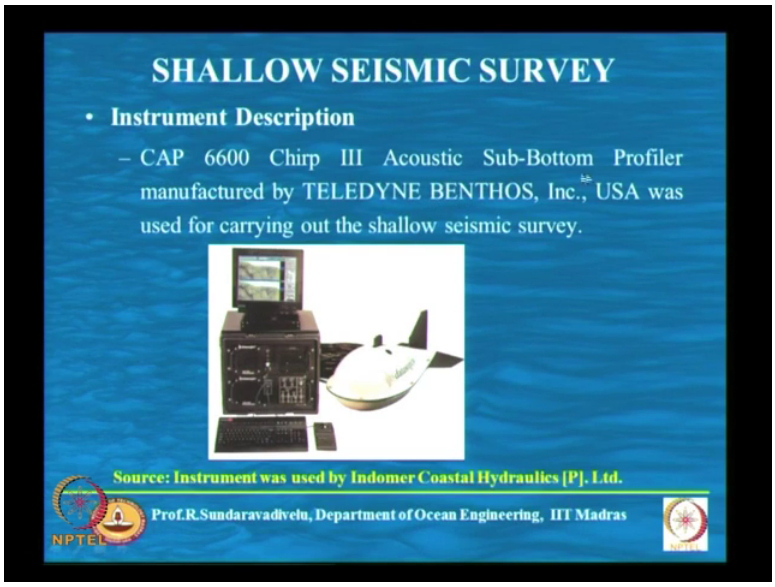


So that is the importance of that. Some of you are sold that subsoil investigation is very much important, that is the geotechnical investigation. Land-based geotechnical investigation is very easy to carry out, you can carry out. But in the open ocean it is very difficult to carry out. So we are using what is known as the shallow Seismic survey, this can be used on the land also. So they are using, this is the trade name of the equipment, Acoustics Sub-Bottom Profiler, it is manufactured by some company, this company name is given, this is used for the shallow Seismic survey.

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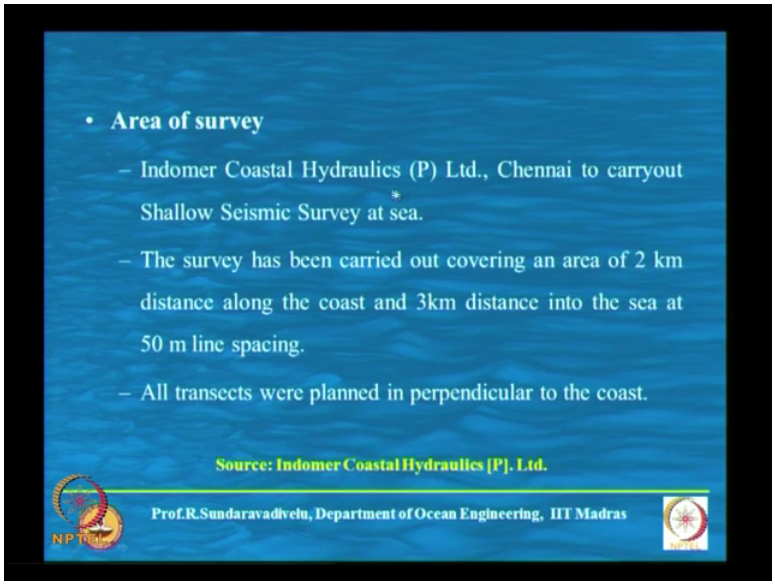


This is being carried out at a location in Andhra, just south of Vizag. This survey is carried out by this company, this is carried out over an area of 2 kilometre distance along the coast and in 3 kilometre distance into the sea and the grid spacing is 50 metre and transects were planned perpendicular to the coast.

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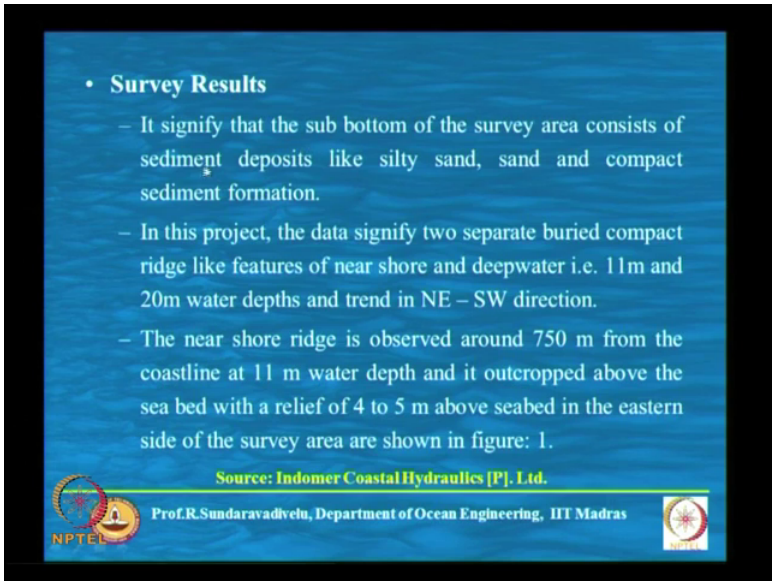


So what it gives is, it gives what the deposit is, it does not give below the seabed but at the seabed what is the deposit it gives. The deposit can be silky sand, sand and compact sediment formation. They have also found out 2 ridges, one is the nearshore ridge, which is observed at around 750 metre from the coastline at 11 metre water depth. And it outcrops, that means it

has come out of the seabed, above the seabed with the relief of 4 to 5 metres above the seabed.

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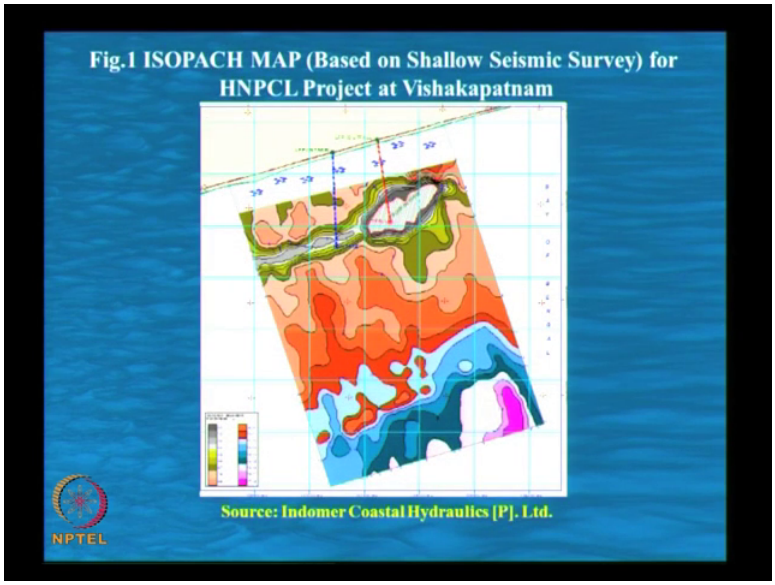


So this is called as ISOPACH map based on shallow Seismic survey. This distance is about 2 kilometres, this distance is about 3 kilometres, ISOPACH means, just like contours these are the lines joining, these lines where they join, now what it shows is, it is not very clear from the figure. When you do the shallow Seismic survey, it should be understood along with the bathymetric survey. So you know the seabed, below the seabed what is the distance below the seabed where we have the hard strata, it can be rock, it can be some other material.

So when you send the acoustic signal, we set in the echo sounder, it goes to the seabed and gets reflected. Shallow Seismic survey is similar to that, but it goes below the seabed and when it occurs, hard strata occurred, from there it comes back. This is clear to you all? What we need in geotechnical investigation, where you have the very good strata, that is what we need. So what it gives is, suppose the seabed is - 6 metre, it goes only another 2 metres and comes back, that means the 2 metres below the seabed you have hard strata.

ISOPACH line shows, let us say this is the 2 metre below the seabed line where you have the hard strata. And this is an outcrop, outcrop means submerged outcrop below the seabed, below the water level, about the seabed, some rock is protruding. And these are all rocks which are available, these are also sediments what is existing. That is what it shows is not only the depth at which you have the hard strata, what are the type of soil between the seabed and the hard strata, that is also shown in this Seismic survey.

So the different colour shows, the black colour shows it is a rock that is there between the seabed and the other places. So you please go through these pictures separately, one of the information you can get is when you have, once you have a submerged outcrop, this is for a seawater intake and outfall system, this is a landfall point, this is called LFP landfall point for the seawater intake, this is the place where we get the water from here. At this location the water depth maybe about 11 metres or so.

So here we have the rock below the seabed, but here we have the outcrop, so this is the discharge, this is APN discharge pipeline, this is the seawater intake pipeline. Since we have the outcrop here which was originally decided, we have shifted this outfall land from here to this point. Please go through this sketch and we will discuss this later. Thank you.