Coastal Engineering
Prof. V. Sundar
Department of Ocean Engineering
Indian Institute of Technology, Madras

Module - 3
Coastal Erosion Protection Measures
Lecture - 9
Coastal Erosion Protection Measures- IX

In the last class, we have been seeing about the problems that has created, that has been created due to the coastal erosion along the north of Chennai harbor. Wherein, the solution was, among the several solutions, one of the solutions was fixing some structures like the pipelines. I told you also why these pipelines are supposed to be given etcetera, why these pipelines are, so, I will just go back just to refresh.

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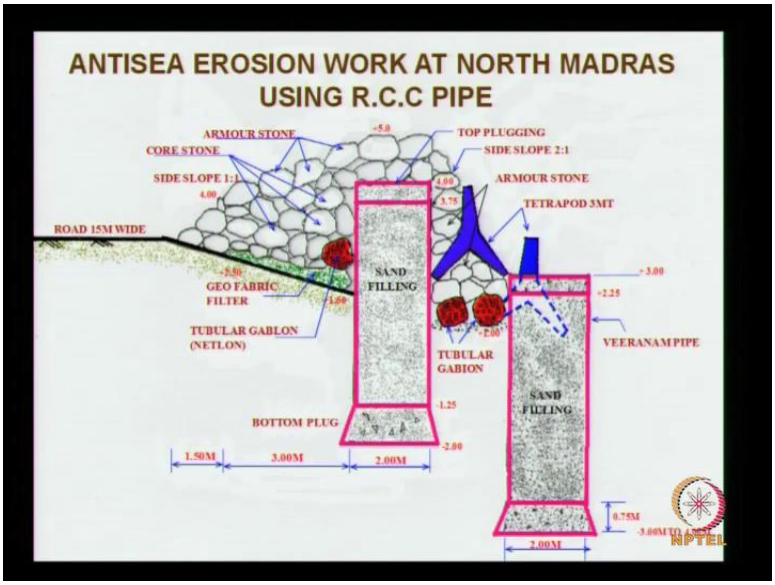

So, this is the kind of a cross section, which they had adopted for coastal protection as we have discussed in the last class.

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So, and then these are the problems that have taken place during the, due to the severe erosion. Look at this road. As I have told earlier that this road which is considered to be a coastal highway has been eroded completely and because of this, you have other problems.

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Now, I will come back to that highway, how we have restored this coastal highway later.

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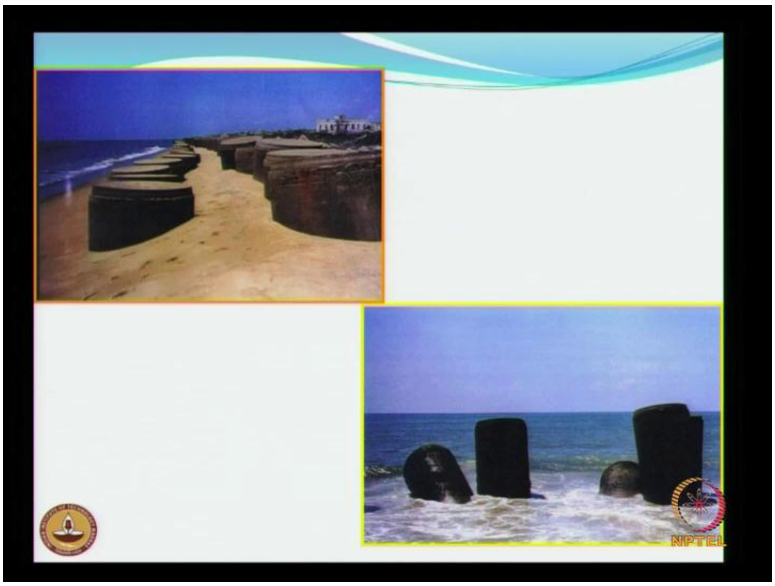

Now, you see that these are the closer view at the status of, this was the status sometime around late 2000, and that is not 2019, early 2000 I would say.

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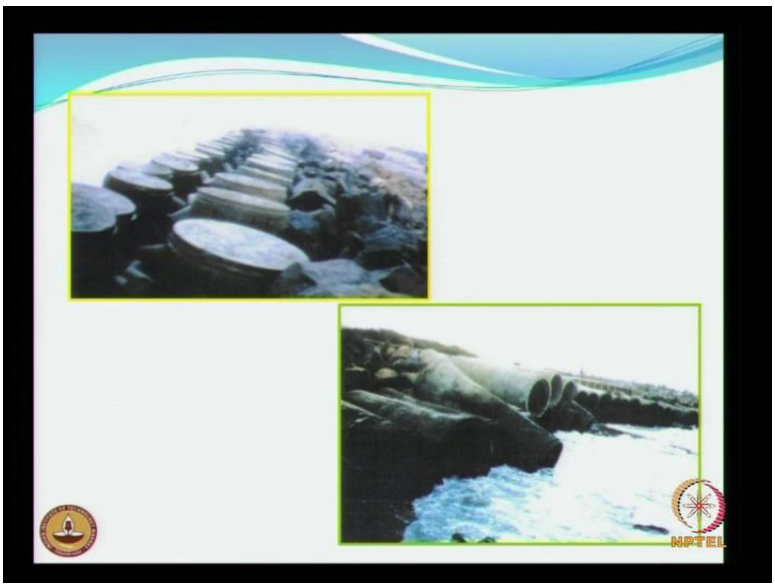

So, these are all some of the pictures. Even there was a ship which got grounded here. From this, this is the south and this is the north. You look at on the northern side of this ship which got grounded. Even that has, that seems to be acting as a littoral barrier. So, you see the erosion taking place. Some of the other things, sea, well, houses, so many things have gone into the sea.

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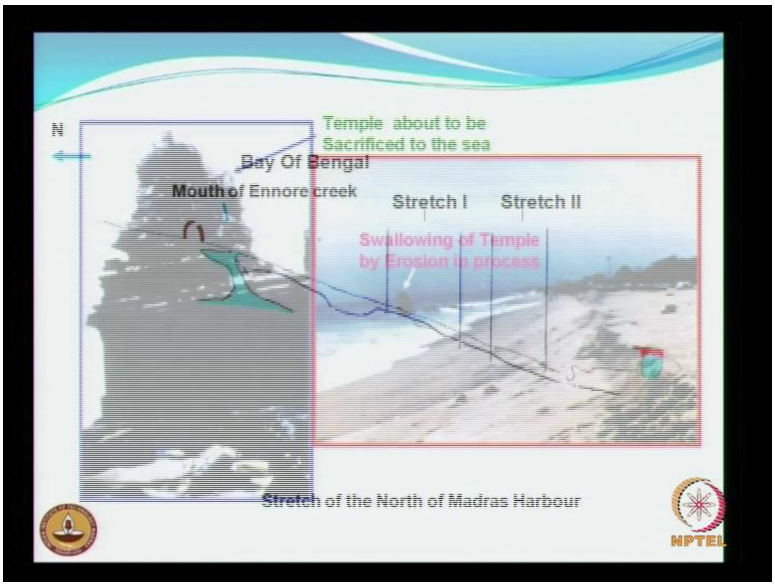

But then, the most important is the temple, which you can see on the left hand side and on the right hand side, you can see the temple in the process of being swallowed by the coastal erosion. Now, this temple no longer exists. It is an age old temple. We have lost this temple to the ocean due to erosion.

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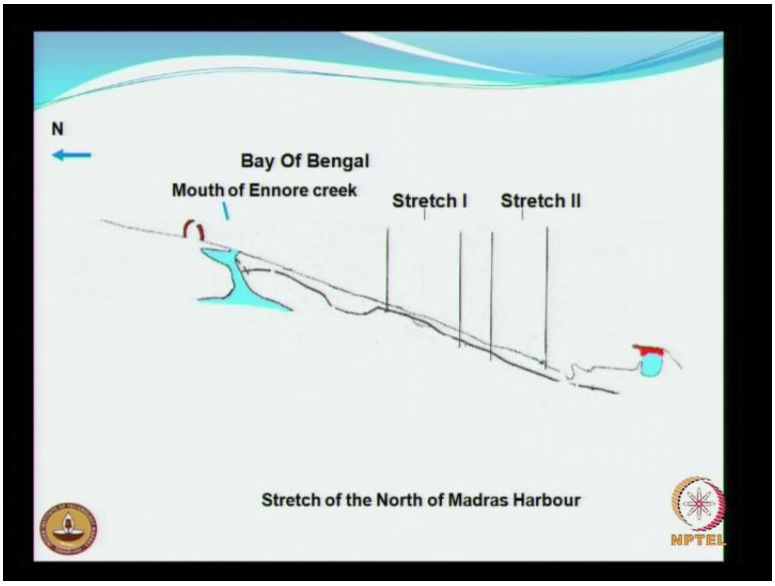

So, this problem as I said earlier, this problem was there for the last five decades, nearly five decades. There has been a number of solutions, mostly like piecemeal solutions, here and there just dumping of stones etcetera. Then, apart from that, there were this

concrete pipes installed as some kind of a long term solution and also sea wall cross sections. All these things really failed. At the same time, you know that this is the Chennai harbor here. This is Chennai harbor. In Chennai harbor, the handling of cargo was going up and they wanted to shift. Particularly, the coal etcetera, from here to some other location and they wanted to develop a new harbor.

So, they decided to develop a new harbor at this location and this is referred to as Ennore satellite port. So, this is and it is referred to as Ennore satellite port. This was located around, since it has to take some of the cargo from Chennai port, they decided that it has to be as close as possible. So then, but it cannot be very close. So, the distance between these two ports, approximately 25 to 30 kilometers and they sighted this. When they sighted this, naturally if you have two ports, it has to connect properly by road and the only possibility of this is to connect the coastal highway. We will come back to this problem etcetera later, sighting of the Ennore port etcetera. So, what happened? This problem was of coastal erosion became very important even before the port could get started. Certainly, once the port comes into operation, if the connectivity is not there, reaching Ennore port also will be very difficult.

So, in 1996 or may be 9, during this time, national highways authority of India, they referred this problem to our department. They asked us to do the survey and come out with the existing cross section, the status of the coast at that point of time and then, come out with some kind of short term solutions as well as long term solutions. So, this was quite a major project and quite changeling. So, out of this stretch, there were two stretches, which was very severely affected. One is stretch 1 and the next is stretch 2. So, this is the Chennai port and this is the Ennore port. Here, we had a river, which is the Cooum river. Now, here we have a river connected to the Pulicat lake. I will come back to that later.

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Now, what did we do? In the earlier, one of the earlier slide, I showed you the remains of the ship wreck. From that point, we went on to do the survey and we located how much kind of, whether there is, see for example here, there was not much of protection needed. So, we identified stretch at every 25 meters interval, we surveyed the whole thing and then, you see, look at those concrete pipes all over. Here, we see that the concrete pipes are in horizontal position. Then, so, and each, the Chainage is also indicated. So, this was the status.

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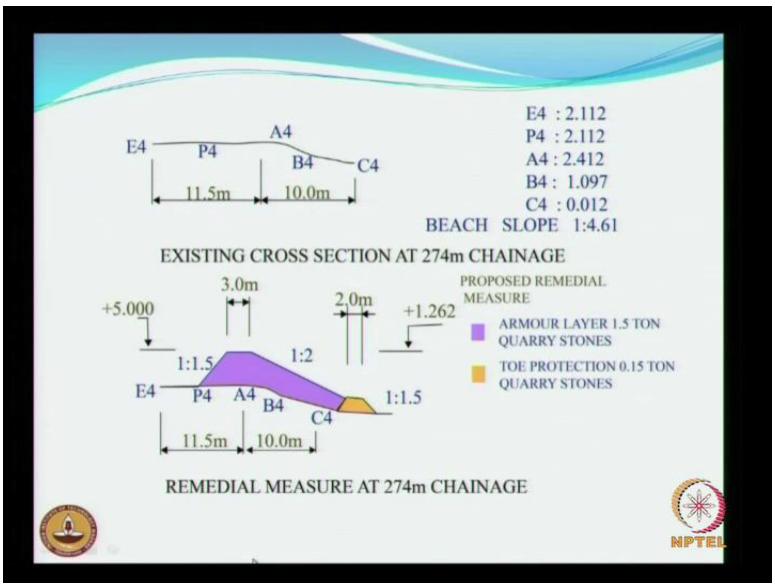

We have to look into the problem of what was happening. So, the sea wall that was in existence at certain stretches, we suggested as an immediate step, provide an armour layer of 1.5 tons of quarry stones and as toe protection, you see the toe protection is very important and this is the kind of temporary relief, so that, they can quickly get started with the rehabilitation of the sea wall.

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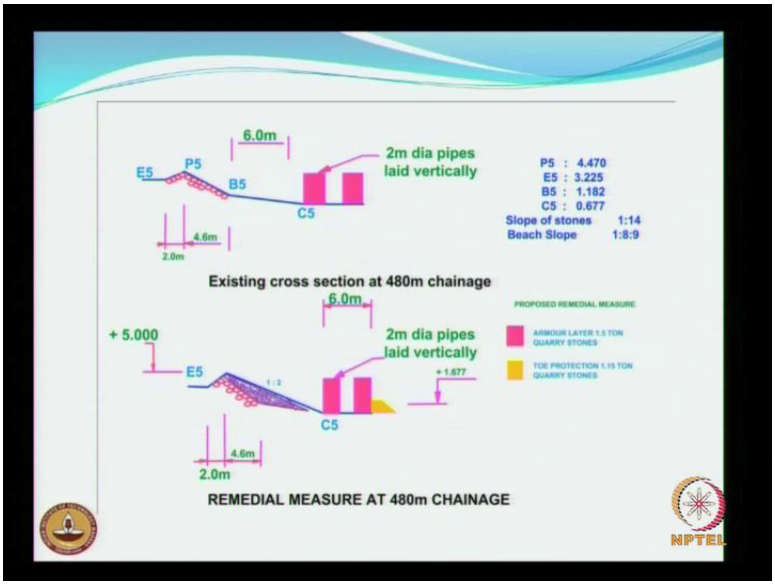

At locations where the pipelines were in vertical, these pipes, wherever they are vertical, they were vertical, we can easily see a lot of scour taking place. In fact, scour hole was there. So, what we had suggested is to protect the pipeline, because, removing the pipeline is going to be very expensive. So, you leave the pipe line as it is, but then protect it and then, but that was never done. So, some of those pipelines stood for some time and then collapsed.

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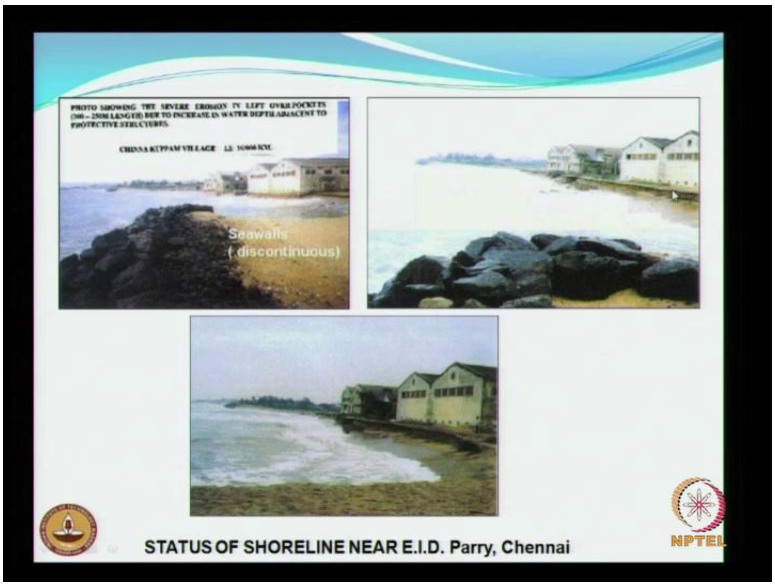

So, you look at this. Some factory buildings around the same stretch, the factory buildings were also being threatened.

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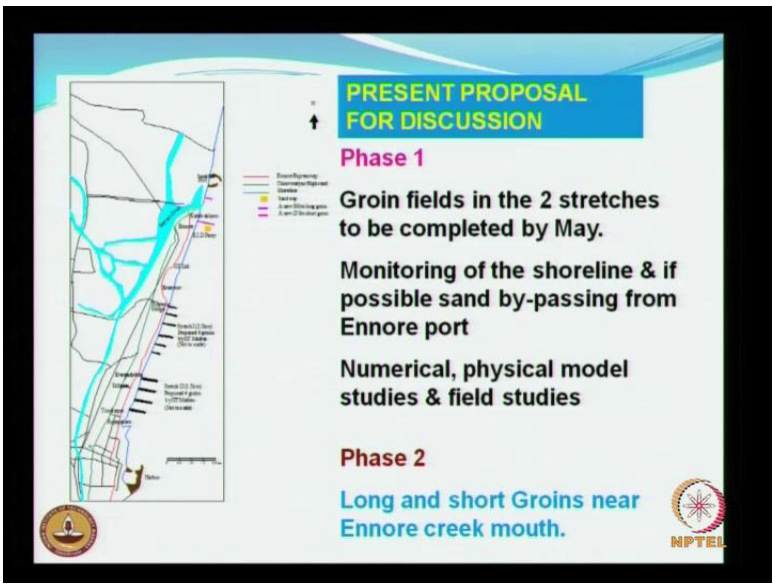

So, what we did is, the proposal after the survey, the initial proposal, this is the Chennai harbor and this is the Ennore satellite port. So, this is the first stretch. This is the two stretches. So, this is one stretch and this is another stretch. Groin field in the two stretches to be completed by May. We will come back to the groin field later. Monitoring

of the shower line and if possible, sand bypassing from Ennore port or even Chennai port was included in the proposal, initial proposal.

Then, we have to take care of, we have to finalize the orientation or the length of the groins, the spacing between the groins etcetera, through numerical and physical model studies. As well as field studies were involved because, we need to carry out some other information about how the process is going on. In the phase 2, we had also included some long and short groins near Ennore and Ennore as well as, in fact, Cooum estuary, I mean Cooum mouth. But then, I will talk about Cooum mouth later. So, there are two stretches. This is the stretch 1 and this is the stretch 2.

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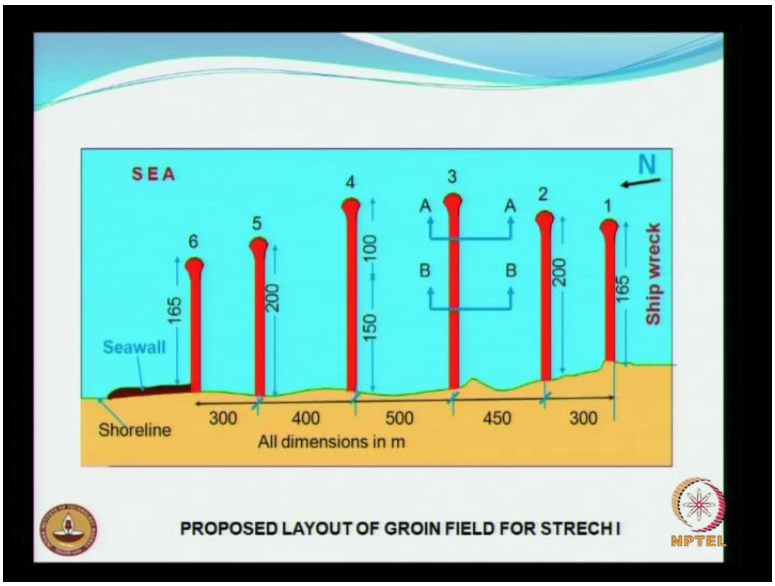

Stretch 1 was about 1.5 kilometers, wherein we had decided for this kind of a groin field. This is the final layout. But, before the final layout was decided, we had gone in for several trials. So, when you decide for a groin field, one basic requirement is, the groin should extend at least one surf width, may be about 50 60 meters approximately. When the length of the groin is less, naturally the number of groins will increase. This is very clear ok.

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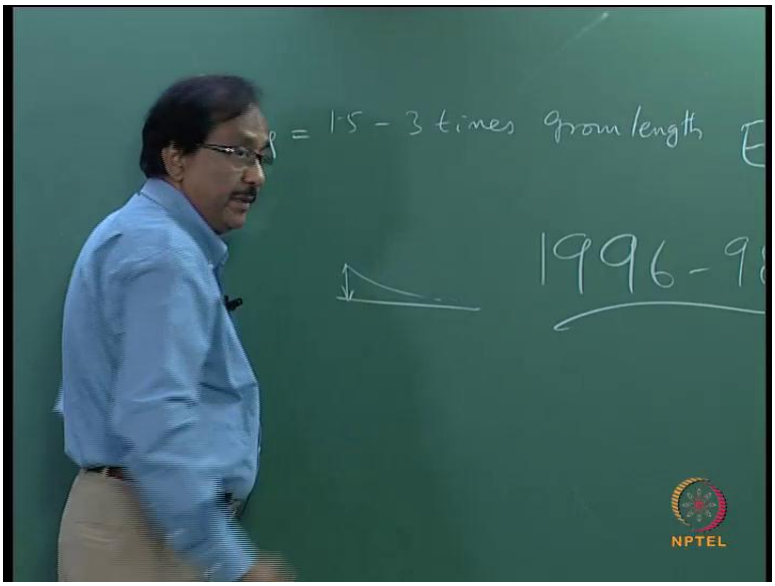

So, the thumb rule is 1.5 to 3 times groin length. That is the, so naturally, if you have, if you use short groins, you are going to have number of groins. If the length of the groin is small, by chance, you get the filling up of the beach or advancement of the shore line. This will, over the years, this will be only up to about 60 meters. But, the requirement, they had a requirement that you allow as much as beach that can be formed. So, we also thought of T groins, short groins and long groins and did lot of calculations and finally, based on the requirement for the agency, we have come out with this kind of a cross section. I mean layout, wherein it is a transition groin. The angle, this should be approximately 6 degrees. For example, if you have, so, this should be approximately 6 degrees. So, I am talking about these groins. So, this is the shore line and this is the sea and when you have this, it should be approximately 6 degrees for effectiveness in retaining the sand.

So, all these things were taking into account and then, the layout was finalized. But, before that, I will just explain what were the other trails also during the course of my lecture.

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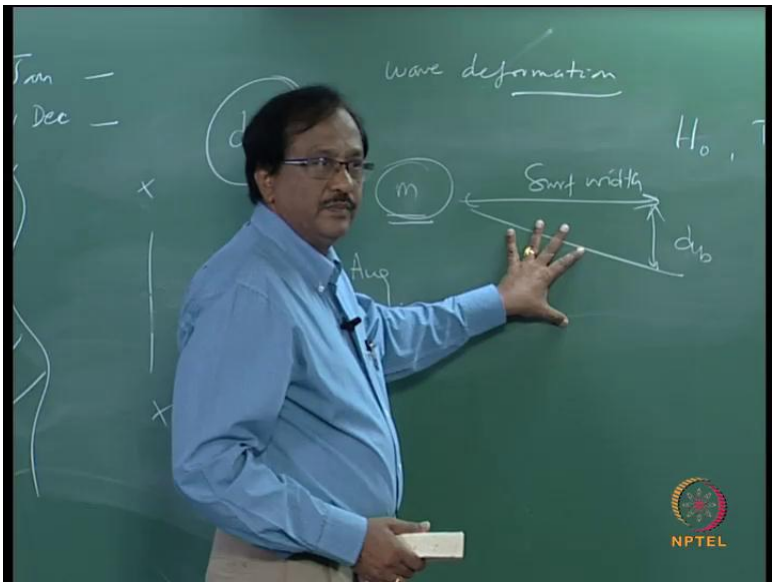

Some of the information what we wanted and what we needed was to look at how the sediment transport distribution looks like. As I said, the sediment transport is concentrated within the surf zone. So, only when, one way of doing it is to calculate the surf width, which is straight forward. How do you calculate the surf width? What do you need? You need only the breaker depth. Look at the lecture on wave deformation, wherein we have a number of formulas for determining the breaker height or breaker depth. Once you know h naught, t, beach slope etcetera, there are a combination of formulas. I mean, each formula posses to some kind of, the type of input data you have with you. So, with this, it is possible for us to calculate your d b. Once you know d b, you can easily calculate the beach slope. Right? So, beach slope, sorry, beach slope is known. So, beach slope is known. Once you know the d b from some of these formulas, then I can get the surf width. Is surf width a constant? No. How does it vary?

Sediment transport.

No. How does the surf width vary? Does it vary every day or every month or how does it vary? Anyone?

Only because wave heights change

No, wave heights change means, wave heights keep on changing. The breaker zone, it is only a zone. Although we call it as a line, see when we talk, this is the breaker line and

we refer this is the shore. We say that this is the breaker line. Although we use that breaker line, it not strictly a line that is, that can be drawn along the shore. Because, every now and then, the breaker, the breaking point can change. For example, even within a day, the breaker line can change. But, the change will not be too appreciable for may be within a month or within a particular season.

So, what you do is, every month you can calculate, January to December, every month I can get my surf width. As far as the design is concerned, when you want to do the design of groin field, you have to cater to the maximum sediment transport. So, as far as this coast is concerned, it will be around June to August, along the east coast of India, where you have maximum sediment transport.

So, this surf width also will be higher. So, I have determined the maximum surf width. So, the groin length should be definitely greater than this maximum surf width. For the simple reason, it can retain all the sand. That is one way of doing it. I can simple get my maximum surf width once I know the breaking wave characteristics. Based on this, my length of the length of the groin is fixed. The other way of doing it, actually what you are supposed to do is, you should go a bit deeper into the problem. Within the surf zone, how does the sand look like? How does the sand transport look like? The distribution of the sand looks like?

So now, I have oriented my lecture in such a way that you are exposed to the field problems. Now, after the lecture, you know what already, why you are doing it, when I take up the problem on or a problem or formulas concerning all these sediment transport distribution or a long shore sediment transport rate etcetera. You understood? Instead of me starting with the problem, I started with the problem with the actual field problems and then, I will be slowly getting into how to calculate all these things.

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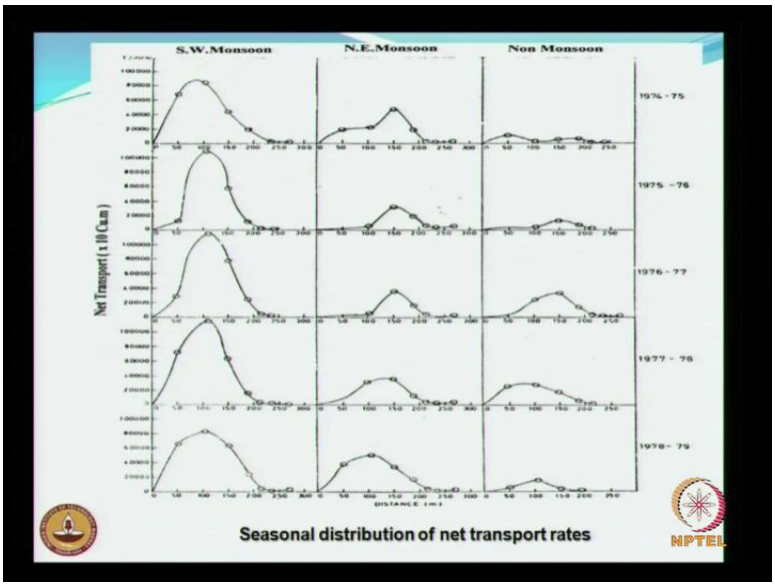

So, we did the seasonal sediment transport, which used to, which gave us some indications like, see you look at this. Even up to about 200 meters, we do have some amount of sand being distributed. So, by having the shorter groin, we will be allowing certain sand to be moved. So, we wanted to be kind of greedy to trap whatever sand is moving.

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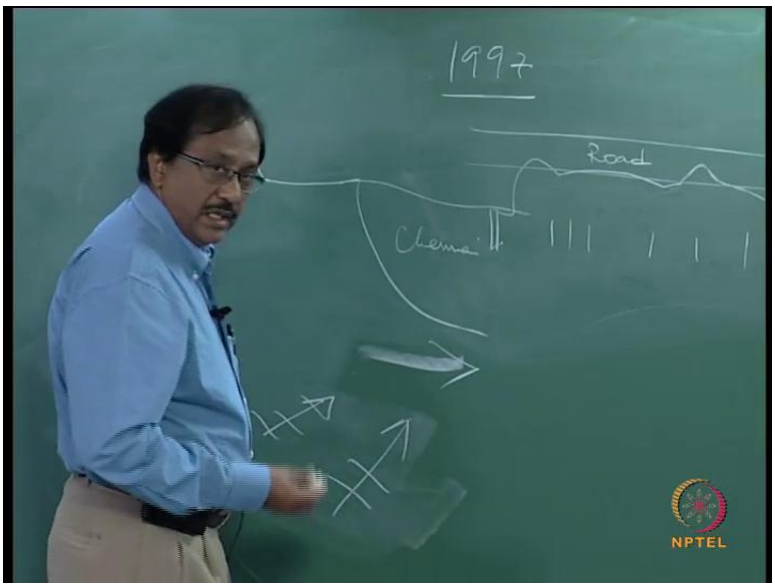

But now, let us come back to this problem. This is the Chennai harbor. You have the Cooum mouth, Cooum river and the wave is moving in this direction, for which the

tranquility is given by this breakwater. Now, I have one more river as we have seen and now, I have another breakwater here. This is Ennore and this is Chennai. How was this coast looking like? The coast was looking something like this and the road was going something like this. You understood? So, this is the road and in fact, this should go something like this. Understood? So now, the suggestion was to have groin field here.

When this proposal was made, the problem, arriving at the solution and proving the validity of the solution to the problem was much more easier than convincing the authorities and other experts. You understood? The simple problem is, why there was objection? When the sand is moving in this direction, most of the sand is trapped here and this is also an eroding area. The sand is already moving from here and when you want to have groins, where do you get the sand from? So, the doubt raised, is it reasonable or not? It was quite reasonable right. So, where are you going to get? This problem was raised all over. Although we came up with the solution in 1997 I would guess, the project had to wait for about 6 7 years to get implemented because, there was a lot of, and because this is an important location and huge amount of money is also involved.

But then, what was the kind of question posed by us? Reset that, this is stopped, but still, the process of the waves, oblique wave attack is going to continue here and this is going to certainly have a long shore currents and it is going to take the sand. If you do not have these compartments to intercept the free movement of sand, the sand certainly will go there. The sand, if that is likely to go there, only that sand is being trapped in between these groins. But still, the sand beyond this groin area will still have its path to move into this area and create problems here. So, this was the interesting problem. So which we could do that and then, we could convince the authorities and finally, we will see the results later.

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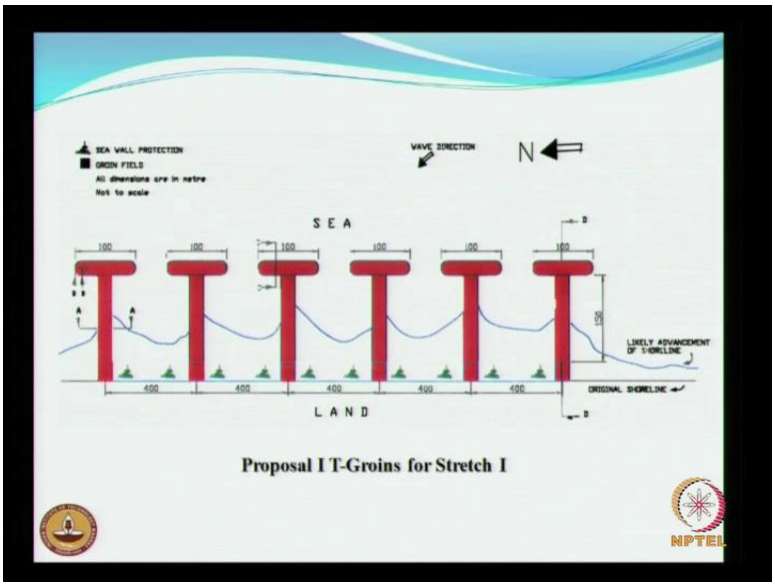

When we started the work, we wanted to have, we tried T groins. T groins, you know that why T groins are suggested? T groins is to retain the sand when it is trying to be brought or trying to be taken away into the ocean during the down wash.

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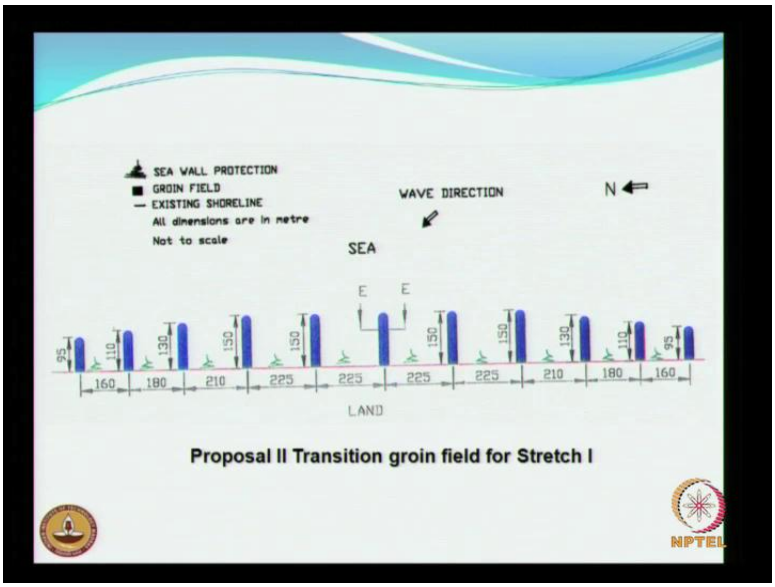

So, we looked at some of these configurations. Short groins extending up to a maximum length of 150 meters. So, you see, so many groins. A number of groins jetting into the ocean also does not look nice.

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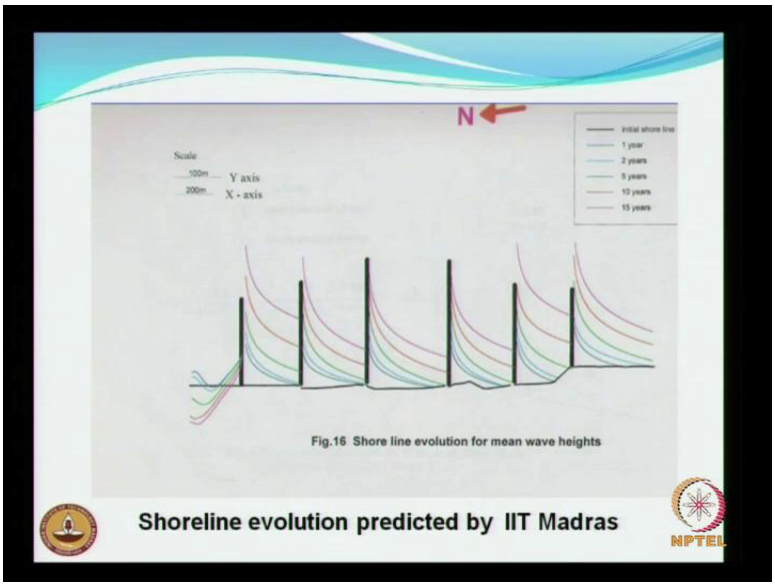

So then, finally we did, this is a very old, quiet an old project, wherein we did the numerical simulation of the shore line evolution. We have now better way of projecting all these things.

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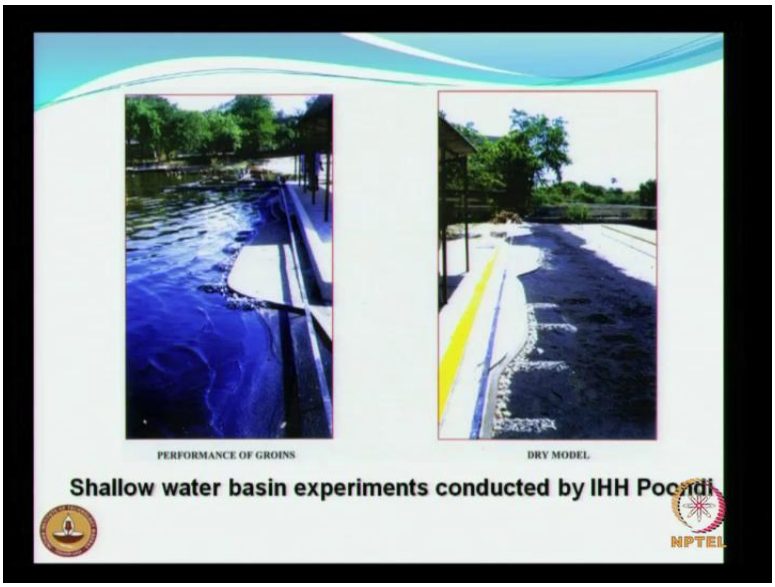

Then, we also did the experiments in Institute for Hydraulics and Hydrology. This is one institute, which is about one and a half hours drive from our institute. So, they have a shallow water basin, wherein we simulated all these information into the wave basin and we tried an attempt was made to consider mobile bed. Sand was also used. Although it

cannot be said that we could achieve one is to one correspondence between the field and the lab, at least we could make some progress in that direction and that gave us a great confidence that the system is going to work.

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So, after convincing all the authorities, groin 6 for the stretch one started sometime in April 2004 I would guess. So, April 2004 the construction sequence also was given.

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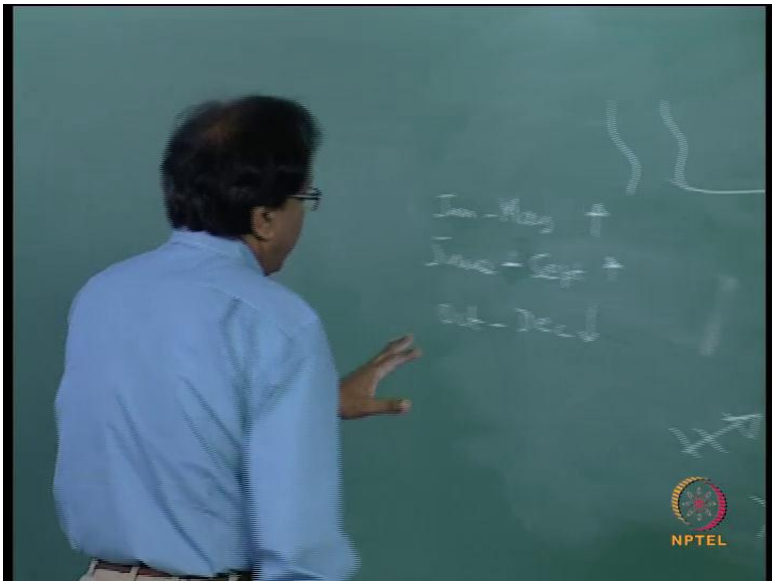

Please recollect that the sand movement is, during January to May, it is moving towards north, June to September, it moves towards north and October to December, it moves

south. How do you know all these things about the direction as well as the quantity? That we will work out a problem later. By then, you would know why you are doing all these problems. Is that clear? So now, when we have, so, the problem was starting the, sorry, the project started in the month of April. When they want to do the project in the month of April, which is the groin you would suggest to be constructed first out of these six groins?

Make it. At least whatever you have knowledge you have gained, you know, you just think and tell me. Groin 6. That is because, I have already indicated here or I have already told. Now the question is, instead of constructing the groin 6, what would have happened if I had constructed groin 1? The erosion will take place on the northern side. So, what we had suggested is, you construct this groin first and then, slowly go ahead with other groins. But, while doing it, make sure that this is properly protected by sea wall. There was a sea wall, which was in existence, but, that has to be modified. So, I should take care of the action of waves. You understood? So, the sea wall was first strengthened and then this was constructed. As far as coastal engineering is concerned, the sequence of construction is extremely important.

So, slowly all these groins; we have now; now you look at the groin 6. The moment the groin construction, see construction is still in progress. You see those cranes? This is anticipated. The moment you put an obstruction, you will see the changes in the shore line. But, the shore line response was similar to what we had predicted in the numerical model. But, may be the magnitude is not to that extent. There is variation because, we are dealing with a host of parameters and then, lot of assumptions involved.

If someone comes and tells that my numerical model is like this and my field is behaving like this in coastal engineering and what is the deviation and if he says the deviation is less than 5 percent, it is quite hard to believe. If the deviation is someone says that it is less than 20 percent, I would gladly accept. You understood? So, even getting up to a deviation of 20 percent, it is not so easy, because there are so many ifs and buts. Is that clear? So now, you see what has happened to all this beach formation.

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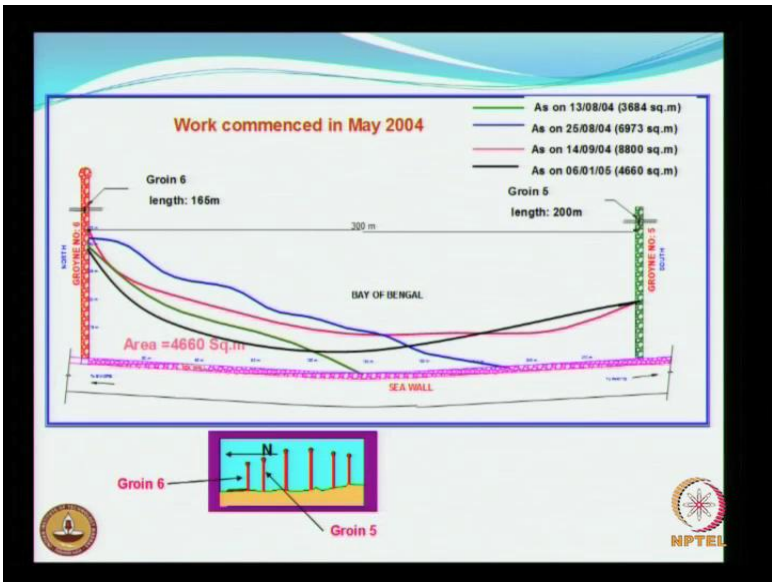

So, any coastal engineering project of this nature, continuous motoring is extremely important. I am sure some of you might be joining some consultancy firm or may be some firm, which is involved in construction etcetera. All these things you have to have in mind. These are some of the issues being faced by some industries working in this area. So we, the work commenced in May 2004 and you see that only the area is being marked here. Approximately 3700 square meters and that was 13th of August 2004. 25th you had something like 7000 square meters and by 14th September, you had something like 9000 square kilometers of beach. But, see 6th January 2005, that around 9000 square meters was reduced to by about 50 percent. 50 percent of the sand. 50 percent of the beach that was found went into the ocean. Can you guess why?

Change in deduction of (())

Change in? Can anyone? What happened in 2004? So, last week of December 2004 we had the tsunami and one of the devastation affect was to remove the beautifully formed beach. That was really disgusting. Really disgusting because, we were so happy that everything, this was only in month of, a solution being worked out. That is, we are getting fruitful results after 5 decades. Beach is being formed. The local people are very happy and we as consultants, we are also very happy. Suddenly, you see within a matter of 6 months from its implementation, you see the sand has gone inside. So, that resulted is some kind of frustration. But then, we continued the monitoring of the shore line and

you see that, whatever went inside the ocean, came back, and had come back with an additional of about 1000 square meter. What happened? What happened?

The sand which was removed from here, somewhere here, must have got deposited here. So, when I draw the; I will draw here. All the sand might have formed here and then, slowly over the time, this is not slowly; it is quite fast. Within few weeks, the water level must have gone down and then, this bar has been removed and re deposited here.

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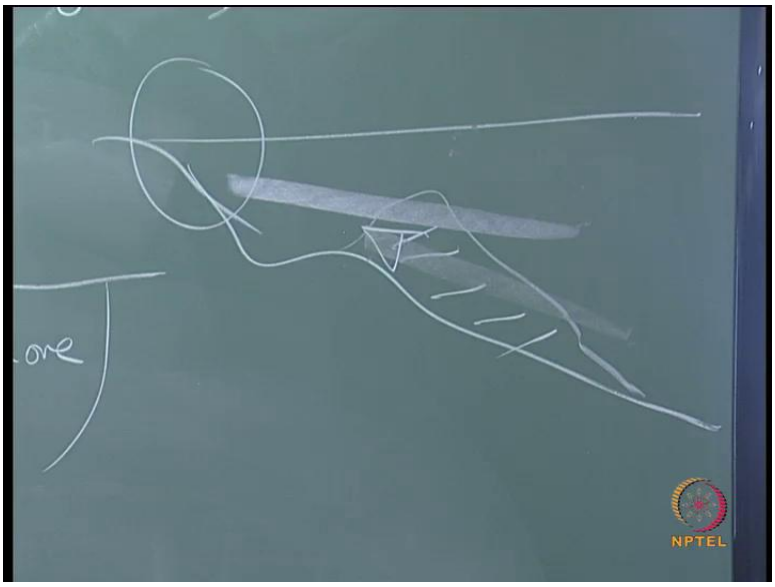

Now, the beach is intact. As on today, the groin field has been quite effective, that is as on today March 2012. So, only thing is care has to be taken for continuous rehabilitation of the groins, because these groins have formed only by dumping of stones. So, you need to monitor and then keep on rehabilitating if it is suffering any kind of damage.

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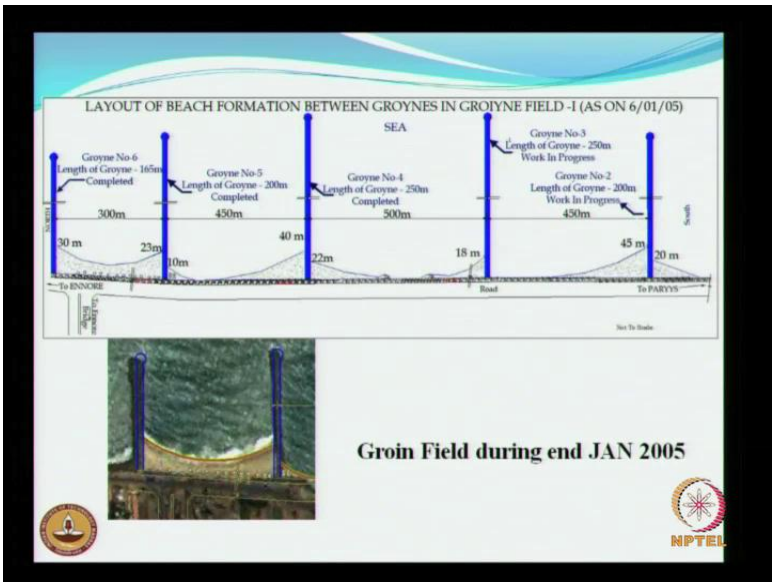

Some of the monitoring information, we also just looked at the satellite imageries and try to understand using the GIS as a tool in order to quantify all these things.

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This is another satellite imagery. So, this is closer view of the beach formation in between the groins taken in September 2004.

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After the tsunami, you can just see, the 28th December, some of the locations were still there with the sand. Tsunami did not remove the entire sand. In some locations, the sand was there and the groins really sustained the tsunami because, there is not much of problem with the groins. So, I will come back to the effect of tsunami when I talk about tsunami interaction.

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So, this is yet another using IRS image. So, looking at the cross section for the groins, this was the groins and this was the section.

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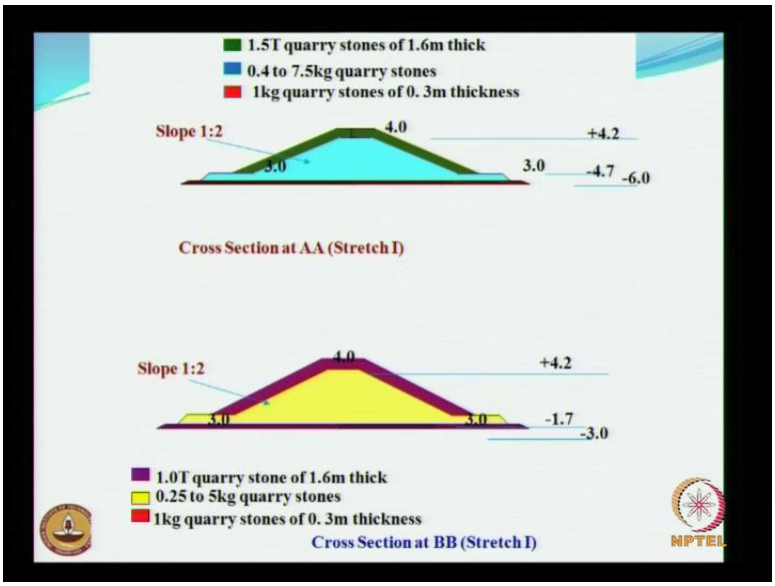

So we had, I think there is some mismatch of the figures. I will try to include this picture. So, forget about the, I think there is some mismatch of the figure. We will look into it later.

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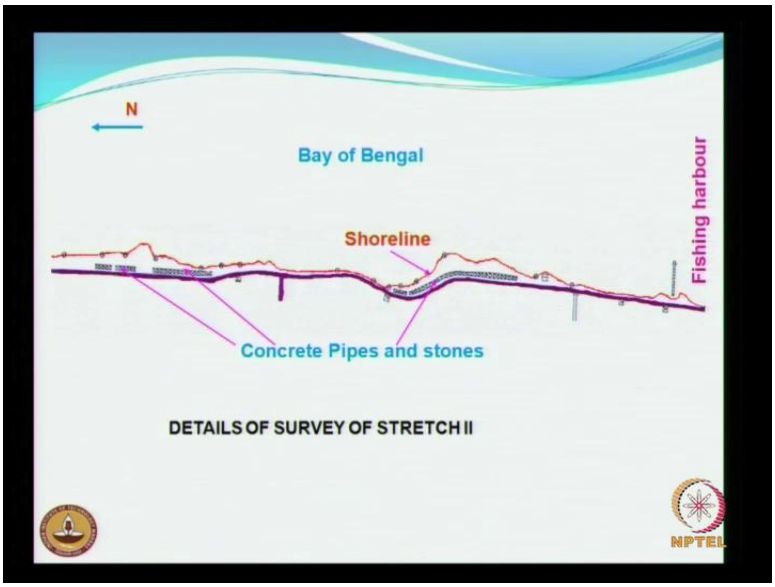

So, details of the stretch 2. There were 2 stretches.

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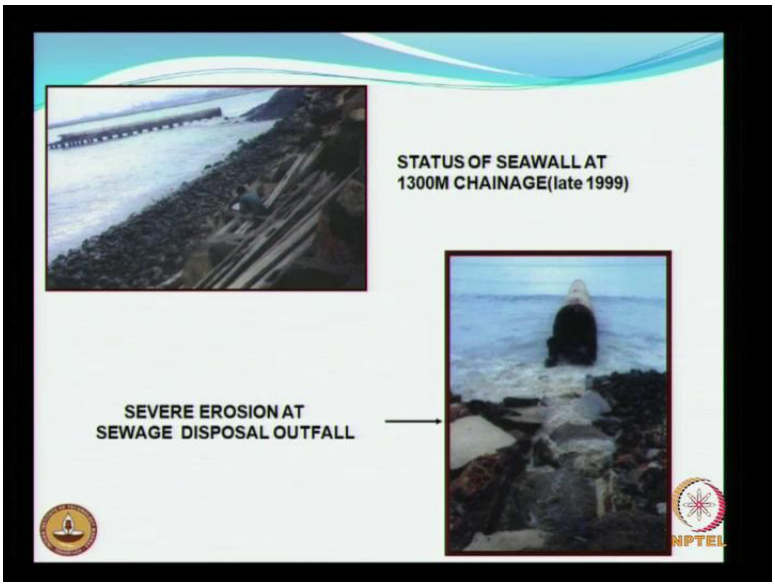

So, this was some stretches.

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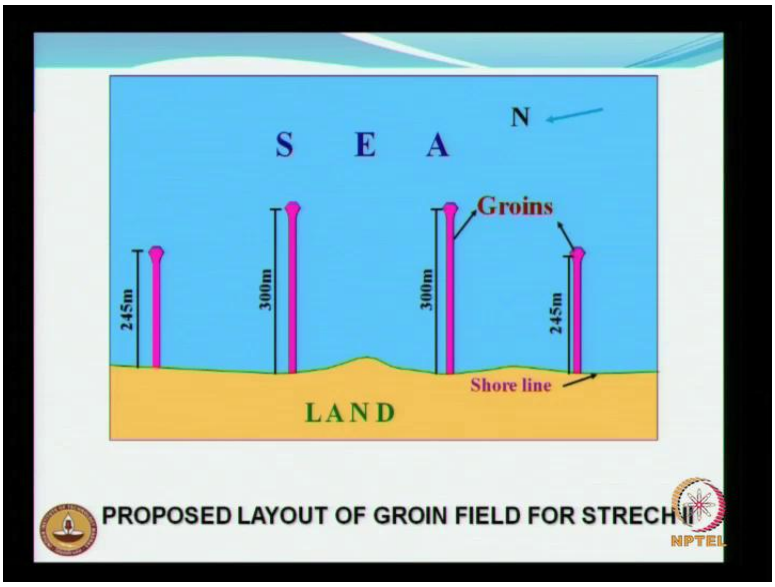

So, I will just, for the stretch 2, this was a kind of cross section we had, because for stretch two, the cut was quite deep. So, we wanted to have more of beach formation. So, that is the reason why you see that the length of the groins quite more.

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So, some of the other problems; see closure or river mouth, sand bar formation etcetera, around the same stretch of area. So, how the sea wall has failed? Because of, look at this, the toe erosion starts. Once the toe erosion starts, then that is a problem. Then, toe erosion continues and the stability of the stones become questionable and the whole thing collapses.

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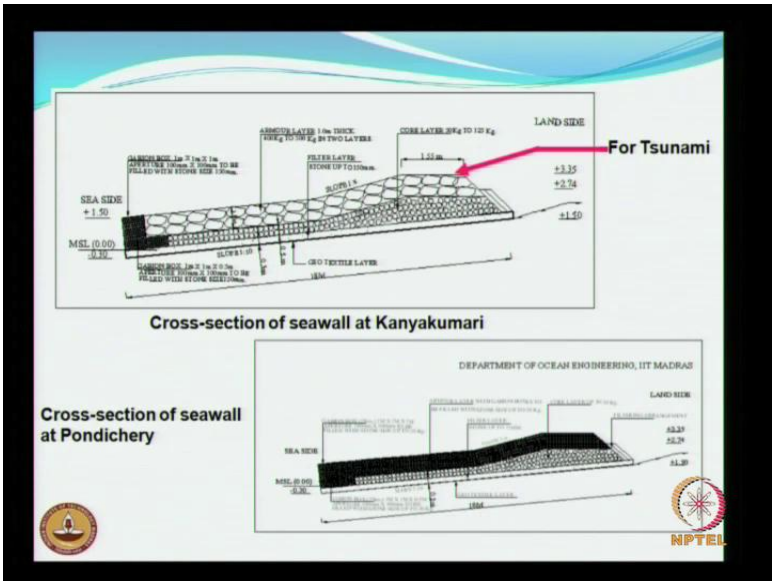

So, we looked at the, I mean the sea wall cross sections, what we had adopted for some of these stretches are shown here. I will be discussing about the other, because of the

tsunami, we have raised the top level of the sea wall. I will discuss more in detail, but, we have provided a strong toe. We have used geo synthetic textiles etcetera.

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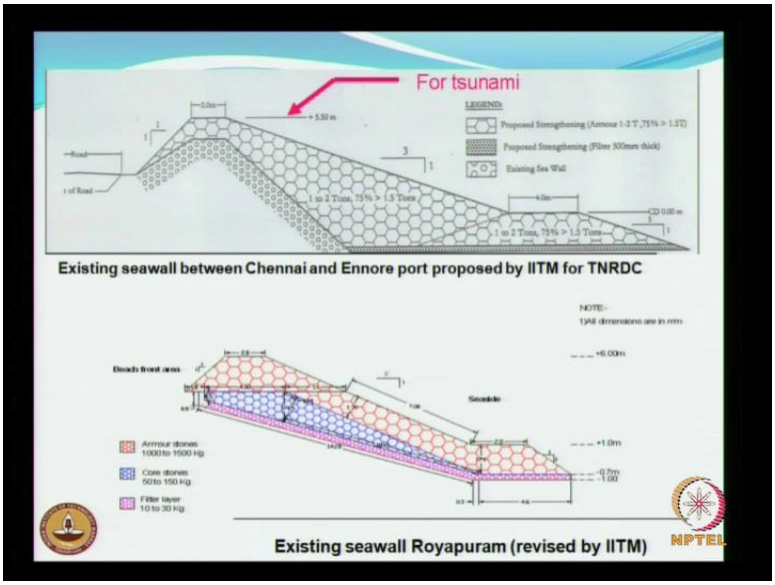

I will come back to this later. But, the sea, you remember groin 6, we had a cross section here. I mean the sea wall, you remember? So, that sea wall was redesigned as shown here. We had a flat slope because, normally the slope of the sea wall is around 1 is to 2. Flatterer the sea wall, more is the advantage. If it is flatter, you can use smaller size stones. So, we adopted a flatter slope and then, this is how we proposed. Strengthening by about, armour stones about 75 percent greater than around 1.5 tons. So, this will be mostly about 1.5 tons and the percentage of this one will be around 1.2 to 2, 1 to 2 tons and with 75 percent of the stones greater than 1.5 tons. This is the kind of specification we had given. They have strictly followed and this sea wall is really intact. There is absolutely no problem. So, in fact, we have given two cross sections to be adopted at two different locations also.

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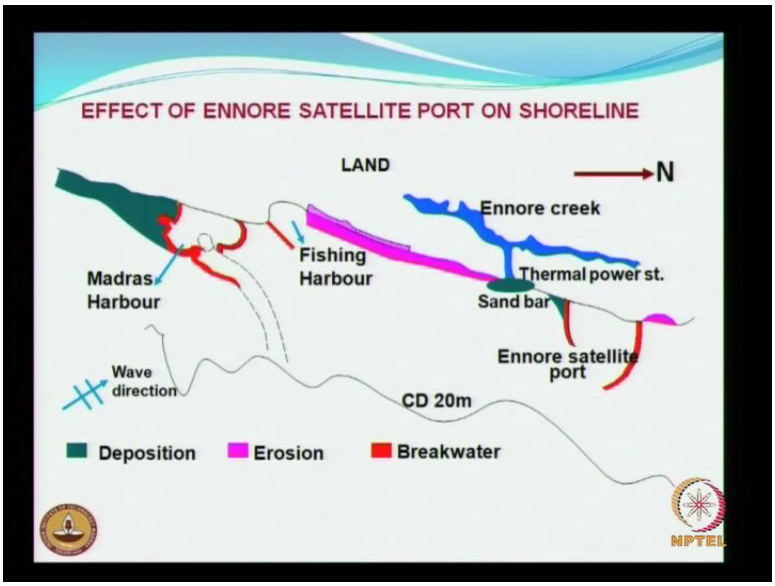

So, all these information are shown in this figure. Now comes the effect of, are there any questions so far? I would be very happy to answer if you have any questions. If you do not have any questions, I assume that everything has been cleared and clarified. Any doubts any of you? Vinay?

This is the scenario. Effect of Ennore satellite port. Now, what was the lesson we leant from construction of Chennai harbor? This is formally called as Madras harbor. Now it is Chennai harbor. What was that was happening? What did we understand by construction of the Chennai harbor there, what was the negative and positive impact? Positive is ok. We have positive. But, what we are worried is about the negative impact. Closing of river Cooum here and then, erosion here. Now, you have another creek here, which is the Ennore creek. We have gone for another port here. The same problem is being duplicated. What are your suggestions? We want a harbor there. I want to hear from you.

We want a, the requirement is that, we need a harbor somewhere here. First of all, you understood now, by having this Ennore satellite port, the problem which we had faced is going to repeat. Now, what is your opinion? Now that you have undergone this course, what is your opinion? Where can we site the Ennore port? You need to be bold. You have already studied. Now, I am sure that I have explained clearly. What is your problem?

That is for, you are suggesting a solution for Ennore creek. Sighting of Ennore satellite harbor itself. If you are given a choice, where would you locate it first? There may be some associate problems, but, first choice would be where? Before the river mouth. That is what I wanted from you people. So, I will suggest to have this before the mouth, because of which the problem of erosion here could be addressed plus you will have erosion of this mouth, because there is a thermal power plant here, which is drawing continuously the sea water from this creek.

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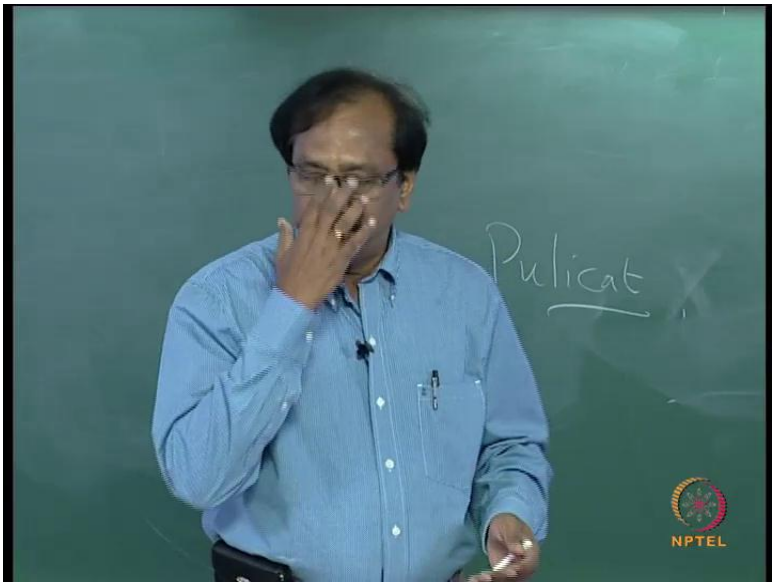

So, this should not be closed. Then, this is actually opened to a big large back water, which is called as Pulicat back waters. You should go to goggle and check all these things. Everything cannot be covered in the class. So, you are right. I would locate this here, so that, I get the merits of nourishing the beach in between Ennore and Chennai harbor plus I keep the mouth open. But, there are other constraints like the amount of land available here was less. So, hence it was decided to shift north of Ennore, north of the wall much against the wish of so many. But, they had their own reasons for shifting. So, one of the reason is non availability of inter land. You need to have good amount of land. Otherwise, it would be difficult.

Then, look at this mouth opening. Are you happy with the mouth opening? Swapandeep, what will happen? What will happen if the mouth is opened like this? Sand will directly go inside the ocean or inside the port. That is very clear. So, you have sand going inside.

So, that is being trapped. Then under maintenance dredging, that dredging, on a continuous basis, it is going on. Now, one of the reason cited by the project authority who implemented this project is that they could not have a opening on this side because, I would have, and all of us would like to have a opening like this. But, there are lots of, large numbers of shoals here. Shoals mean submerged rocks and dredging through submerged rocks is going to be very difficult. That is the reason why they have an opening from this side. Again, this is again much against the wishes of so many. But, the implementing authority, they have own their own reasons. So, with this I will complete today and we will continue in the next class.