Ocean Structures and Materials
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Module - 1
Lecture - 1
Introduction and Objectives

Ladies and gentlemen, welcome to module one of a course on ocean structures and materials. Ocean structures and materials is a very important fundamental course, which is of inter-discipline in nature, which can be attended by almost all branches of engineering students. This is a virtual course which been discussed under the braces of NPTEL, IIT, Madras. I am Dr. Srinivasan Chandrasekaran, Department of Ocean Engineering at IIT, Madras, who will be the instructor for this course.

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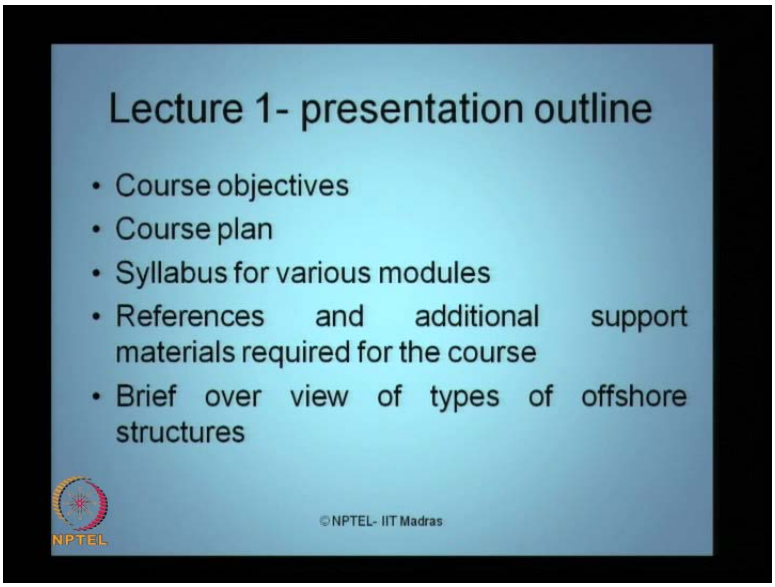

Let us quickly see what will be the presentation outline of this lecture one of module one. We will talk about course objectives in this lecture. We will talk about how we are going to plan for the course, in this lecture. We will discuss very briefly in detail about the syllabus for various modules which I will be covering in this lecture. We will also talk about some references and additional support materials that are required for this course. Of course, I will also give you where a very brief over view or different types of offshore structures in this lecture.

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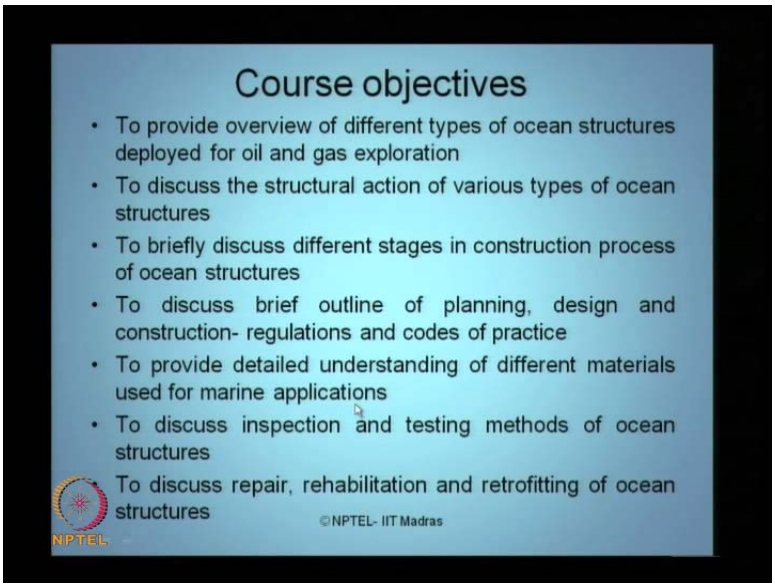

So, now, the course titled ocean structures and materials, is a very fundamental and interesting course which can be followed by any engineering student. For your understanding, let me tell you, this course has got multi-disciplinary initiatives. An engineering student with civil engineering background, structural engineering background, naval architecture and ocean engineering can all understand this course in a very simple format. Graduates with mechanical engineers, electrical engineering, chemical engineering, chemistry, physics will also find this course very interesting, because the course will be cover in a very simple module for you to understand.

Let us look at the objectives of this course. The principle objectives are the following. We would like to provide a complete overview of different types of ocean structures, which are generally deployed for oil and gas exploration in sea. We will also discuss the structural action of various types of ocean structures, which will be deployed in sea for oil and gas exploration. The course will also discuss very briefly different stages of construction operation and process, which are happening in the construction, installation, and commissioning of various types of ocean structures. The course will also discuss briefly planning, design, and construction-regulations and also highlight certain important aspects which are recommended by international codes of practices. We will also cover and make you to understand in detail different materials, which are used for marine applications. We will also discuss different methods of inspection and testing of

ocean structures. Interestingly, we will also discuss the advanced methods of repair, rehabilitation, and retrofitting of various ocean structures under this course.

Ladies and gentlemen, can very well see here that the objectives of the set course are very broad in spectrum. It has got interest of chemical engineers, civil engineers inspection and testing may attract mechanical, electrical, electronic engineers. Material science and metallurgy students will be interested to undergo detail understanding on different materials used for marine applications. Structural engineers, naval architects, and civil engineers will have interest in understanding the construction process, structural action, analysis and design and planning guidelines based on different international codes of practice.

So, ladies and gentlemen, be prepared, you have a multi-disciplinary classroom in front of you, where I will be handling all these points as objectives of the course in a very simple manner. It is the one of the interesting and fundamental course which one has to undergo in ocean engineering and naval architecture.

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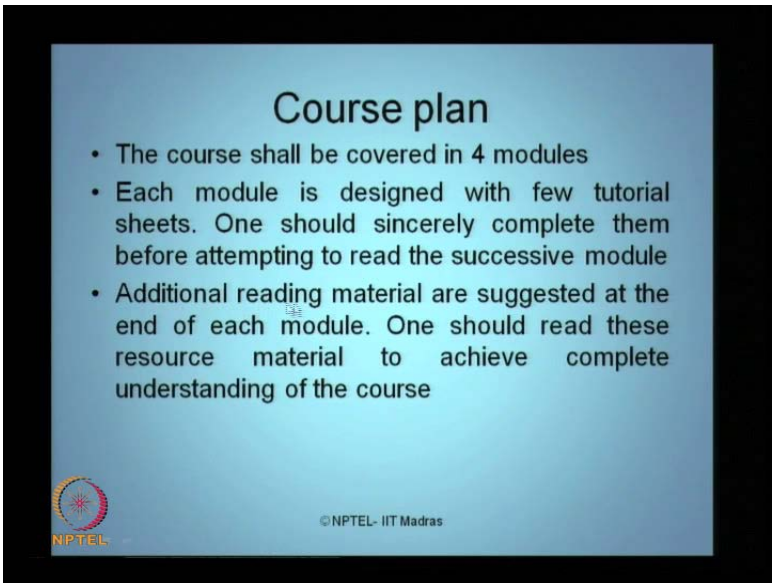

Let us see how you are going to plan for the layout of this course. The course shall be covered and instructed by me in four different modules. Each module is designed with few tutorial sheets at the end. One should sincerely complete these tutorial sheets before attempting to read the successive module. Is my principle request to all the viewers that attempt to solve all the tutorial sheets on your own with the support material given in this

course. You should also refer to additional reading material which are suggested and the end of each module; one should read these resource materials to achieve complete understanding of the course. As I said, I am addressing an audience of multi-disciplinary in nature. Therefore, I will cover the basic and fundamental concept of the course in detail. However, I will always recommend strongly each one of you should go through additional reading material, if you really want to well understand the course in depth.

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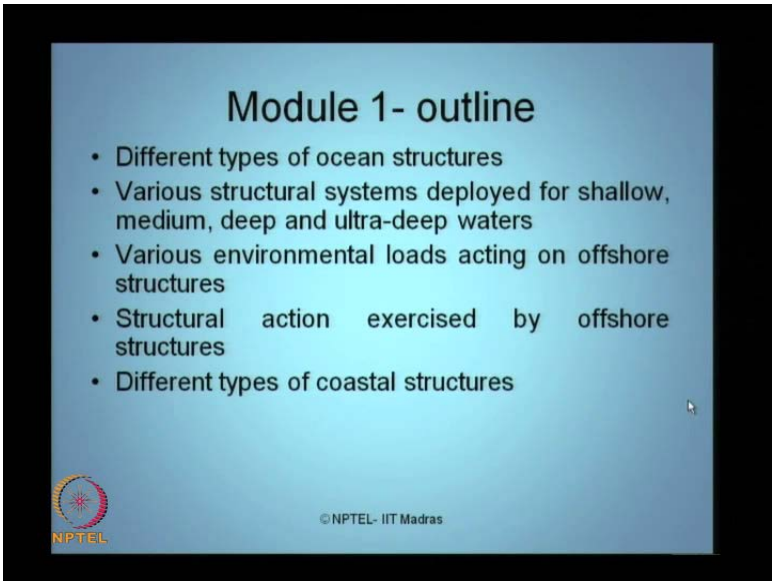

In module one, we will talk about different types of offshore structure. We will discuss various structural systems deployed for shallow water, medium, deep and ultra-deep waters. One may wonder, how do we classify depth of water of shallow, medium, deep and ultra-deep. I will tell you the classification in the due course when we explain the lectures. However, it will be interesting for you to know that is the different structural systems deployed for different water depth or not similar. Their structural actions where varied variedly, therefore one must understand for different kinds of water depths what kind of structural system should I suggest.

We will also discuss various environmental loads that are acting on offshore structures. We will very briefly discuss the structural action exercised by the installed offshore structures in sea. We will also discuss about different types of coastal structures in the first module.

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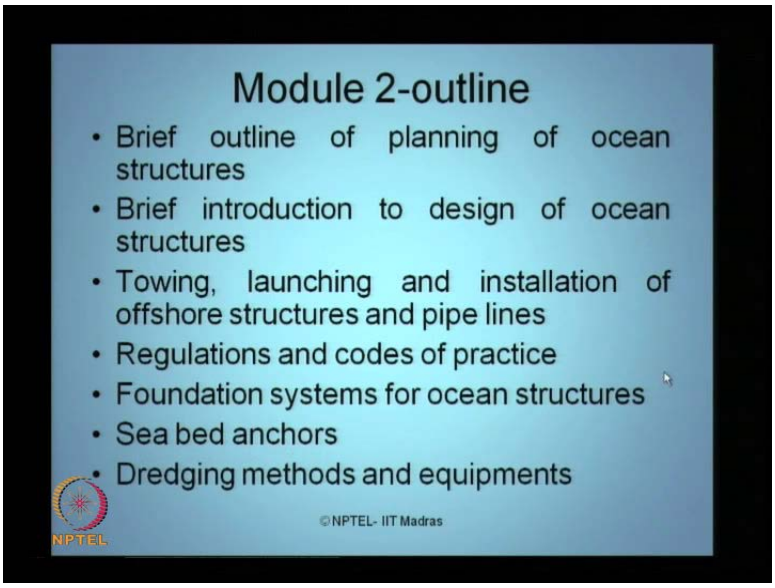

As we move on to the second module, we will discuss briefly in the planning, which are necessary for constructions of ocean structures. We have also briefly introduced you to the design of ocean structures. Ladies and gentlemen, you will appreciate that the design of ocean structure by itself is a full course. So, I will discuss here only basic fundamentals which are applied to the design of ocean structures. We will also discuss different processor involved in the constructions of offshore structures like towing, launching, and installation. We will also see the same process applications for pipeline installations.

We will also discuss regulations and codes of practice that are used for planning, design, construction, and maintenance of ocean structures. We will very briefly see different types of foundation systems that are generally used for ocean structures. We will also discuss different types of anchors, which are used for holding down these structures to the sea bed. All these topics will be covered in module two.

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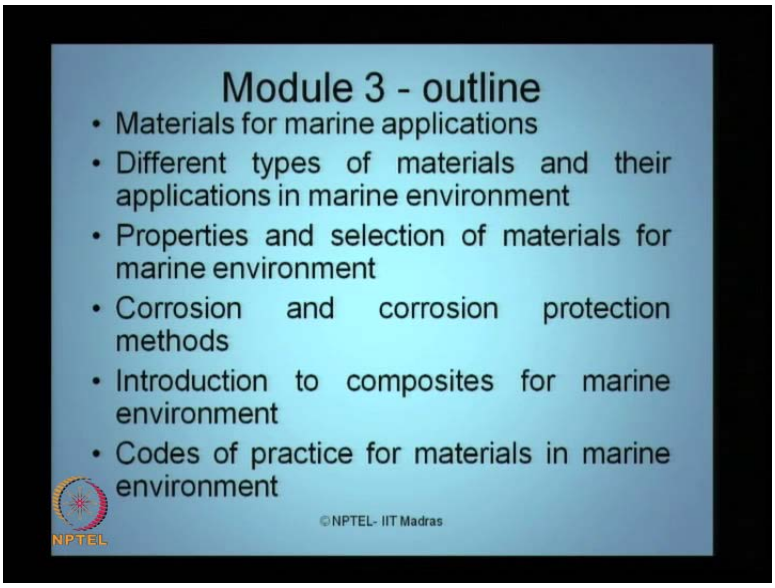

As we move forward, we will also discuss in module three, material for marine applications, different types of materials, and their applicability in marine environment. We will also discuss in detail various critical properties that are useful in selecting a material for marine environment based on international coddle regulations. We will also address specific problems that are related to materials, in particular, in marine environment. For example, corrosion for steel is one of the critical problem, which will be addressed in detailed in this course. We will discuss about the problems associated with corrosion of metals in marine environment. We will also discuss what are the various corrosion protection methods and techniques that can be used for protecting the marine structures from corrosive environment in the sea.

We will also talk about composites which are recent development used in the construction of marine structures are used in marine environment in general. Of course, it is a very elaborate area which requires lot of material characteristics' understanding. So, we will not get them in detail; however, we will talk about introduction to composites as material for marine environment. We will also discuss different courses of practice, which are used for selecting materials in marine environment. All these things will be covered in module three.

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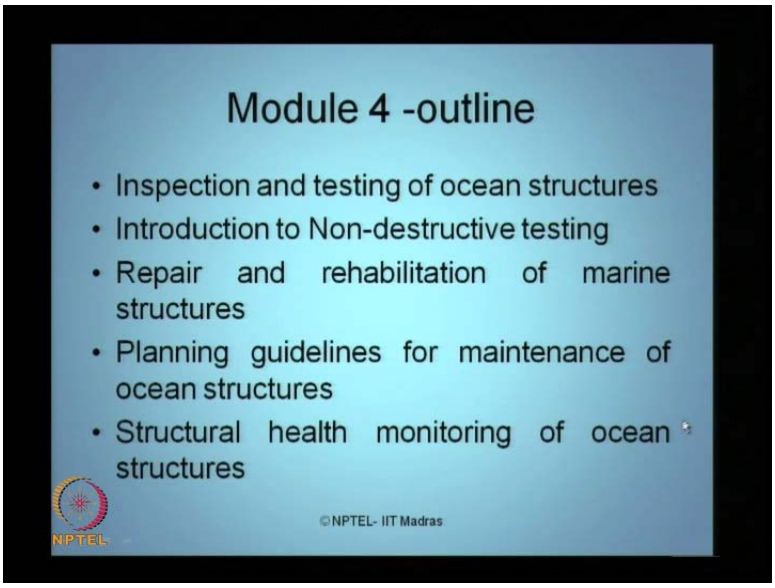

In module four, we will talk about inspection and testing of ocean structures. Ladies and gentlemen, it is one of the interesting segments where lot of reasoning investments in terms of research and development is happening in the oil and gas sector. Because offshore structures are even cost to structures are highly very expansive when they are constructed. Generally their material detrition happens at a very rapid rate than expected detritions characteristics. Therefore, one is interested to maintain the service ability or extend the service life of existing structures for few more couple of years. If that is the goal of any offshore engineering company, then one should invest on periodic inspection and testing of ocean structures for preventive maintenance. We will talk about that in module four.

We will also talk about various methods of non-destructive testing as applicable to ocean structures. We will also to discuss difference advanced materials, which are used in repair and rehabilitations of marine structures. We will also to discuss, what are the possible planning guidelines, which can be used for maintenance of ocean structures. All these things will be discussed in module four. Finally, in module four has one of the advanced topics are research; we will talk about structural health monitoring of ocean structures.

Ladies and gentlemen, structural health monitoring is a very common methodology and common practice being use in bridges and land way structures for extending the service

ability or for emphasizing the safety. However, in terms of ocean structures, this is really a new domain of research which is still under very strong exploration. We will talk about some advanced methods of SHM as applied to ocean structures in this course. So, as you from this presentations made by me, you will understand at that the course covers elaborately many set objectives an audience address of inter-disciplinary in nature.

Therefore, one can really trust that the course will have fundamental addressed in a very simple manner, so that every designer can understand and fulfill their basic requirements of understanding fundamentals of ocean structures and relevant materials as on today applicable to marine environment. Nevertheless, the course will cover interesting features which can attracts construction engineers on repair and rehabilitation of marine structures. Of course, it can attract professionals because the course will also address planning guidelines for maintenance schedule of ocean structures. The course can also attract research engineers who are interested on advanced techniques of structural health monitoring as applicable to ocean structures.

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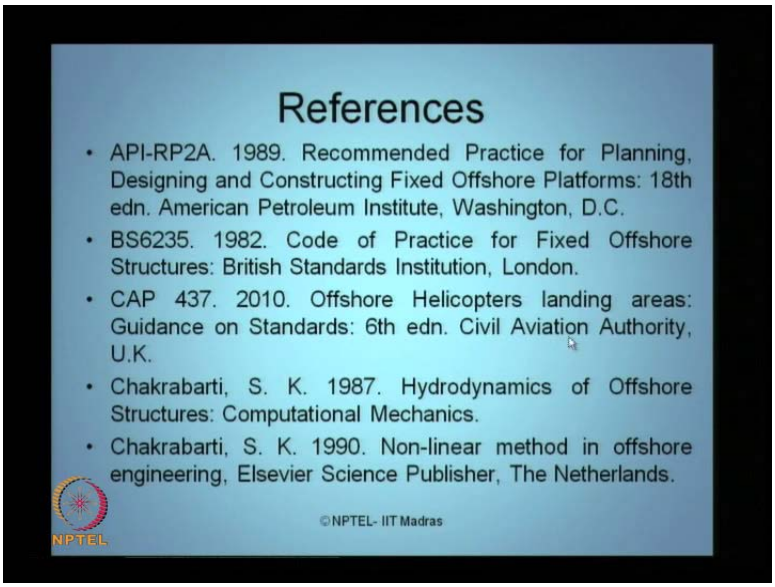

For every course as we all understand the text books, reports, and reference materials are very important. So, in that contexts let me list few important reference materials available now. The detailed list of these reference materials are available in the template given in the NPTEL web site again this course title ocean structures and materials. I am not going to reproduce all those references indicated on the template on the first page of

NPTEL, but nevertheless, I will certainly mention some important references which you would require to follow the course. My sincere advice is locate the nearest possible library, try to locate all these books or reports in original. Try to read them in detail as you keep on following this course parallelly. That will help you to do a very good capacity building on your own.

API-RP2A is a very important reference we have. American petroleum institute recommended practice 2 A is a transfer a substitution which talks about recommended practice for planning, designing and constructing fixed offshore platforms. So, only one type of offshore structures has been discussed in detail under this executive report, it is an international code of reference which is a very important reference for this course.

Similarly, we have code of practice for fixed offshore structures released by British standard institution UK, which is given as BS6235 released in the year 1982. We also have ascertained standards which will help you to plan the (( )) facilities for helicopter landing, offshore helicopter landing areas guidance on standards sixth edition given by Civil Aviation Authority, United Kingdom. Similarly, we have very good text books written by (( )) researchers and authors available in the public domain for example, Subratha k Chakraverthy book published in 1987 on hydrodynamics of offshore structures, computational mechanics very important reference which can be handy for this particular course.

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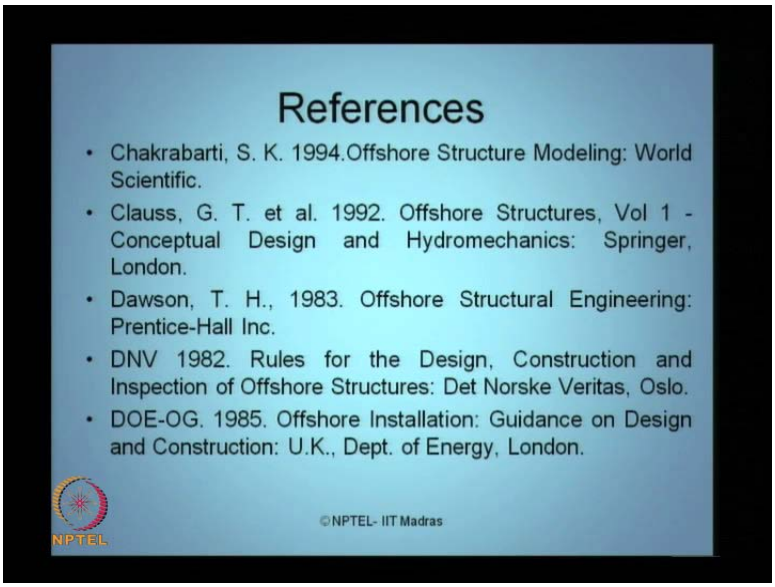

S K Chakraverthy's non-linear method in offshore engineering is an interesting reference. S K Chakrabarti offshore structure modeling publish the world scientific is also very important reference for the course. Clauss G T offshore structures value in one explains conceptual design and hydromechanics involved the design of offshore structures published by Springer, London. Dawson is considered to be a one of the very important fundamental book on offshore structure engineering. I personally request each one of you to have copy of this book, because this book gives compressive detail of almost all course contains refer in this particular course in a very Capsuled form.

Of course rules for designed construction inspection given by DNV released in Oslo in 1982. It is a very important reference which will be very handy concept and topic of these courses. DOE-OG, 1985 released by department of energy London on offshore installation talks about guidance on design and construction of installations is also in interesting reference, which can be used by the user.

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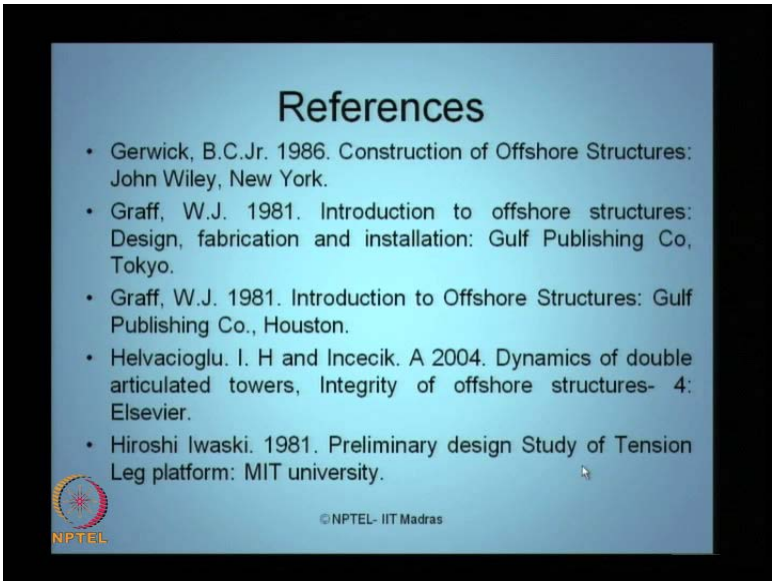

In addition, Gerwick released a book in 1986 by John Wiley, New York. Let us talk about cost of construction involved in offshore structures is the very interesting reference for self-learning. Graff released in 1981 talks about introduction offshore structures, explains various stage of introduction offshore structures as design, fabrication, installation and commissioning.

Graff also has a book on introduction offshore structures, which is given by gulf publishing company in the same year 1981. Helvacioglu and Incecik discuss dynamics of double articulated towers which is the one of the type of the offshore structure is expressed in Elsevier in 2004 in release volume four. Hiroshi Iwaski discusses preliminary design study on TLP, which is the report published by MIT university United States. It is talking about the design concepts of tension leg platform, which is one of the types of offshore structures which is very vital and very latest development in offshore structural engineering.

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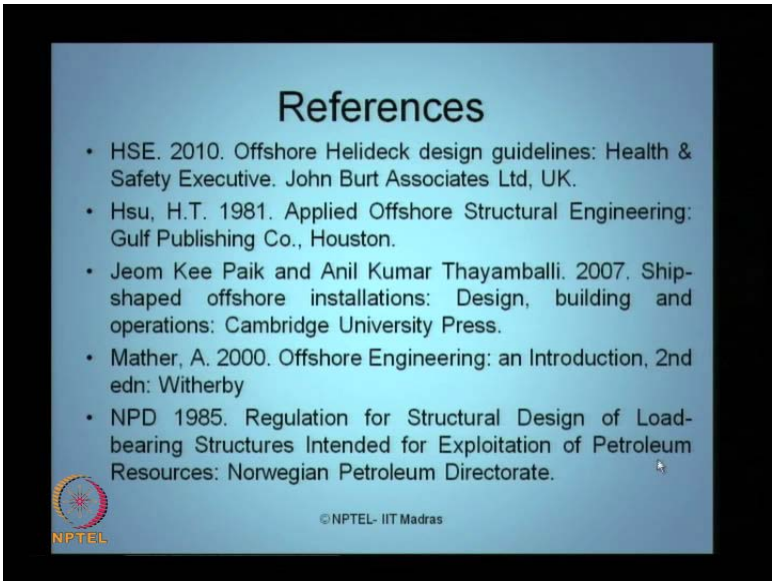

Continue with the references we also have books on health safety executives talk about planning guidelines for Helideck in offshore platforms given by john Burt associates limited UK released in the year 2010 co has a book on nineteen eighty one applied offshore structural engineering. The very important book for reference, Jeom keepaik and Anilkumar Thayamballi, has a book on ship shaped offshore installation, talks about design building and operations which is an executive report released by Cambridge university press matter. As a book on introduction offshore engineering released by two thousand very interesting reference regulation for structural design of load bearing structures intended for exploitation of petroleum resources. The report submitted by Norwegian petroleum directorate in 1985, we shortly called as NPD, by the very interesting reference. Very handy for the learners understand many concepts explained in this course.

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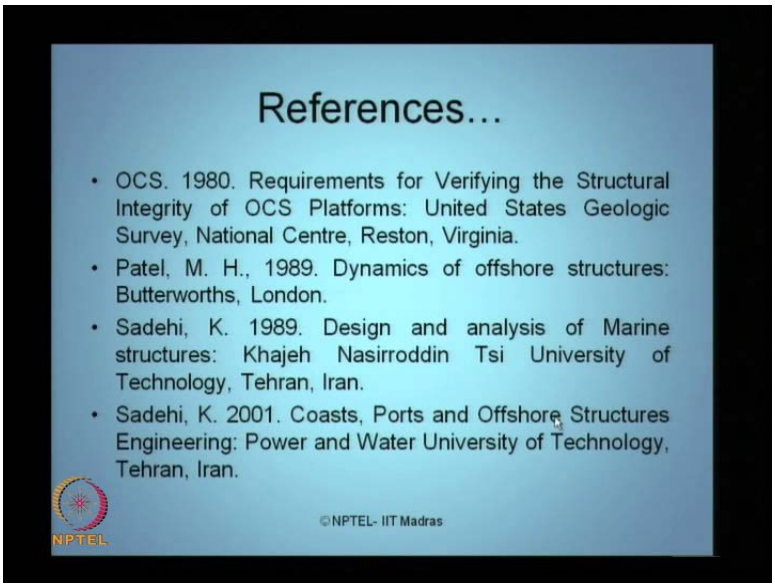

OCS which is talking about the requirements for verifying the structural integrity of offshore platforms released by us, geological survey in execute delete port released in 1980 is a very important reference. Patel discussed about dynamics of offshore structure in 1989 talks about different types of load carrying capacity of the structures in the dynamic associated with environmental loads acting on the structures. Very interesting and basic reference, handy for many learners to talk about design of offshore structures.

Sadehi in 1989 explains design and analysis of marine structures which is the University of Technology, Tehran, Iran. Report can be referred as a very good reference.

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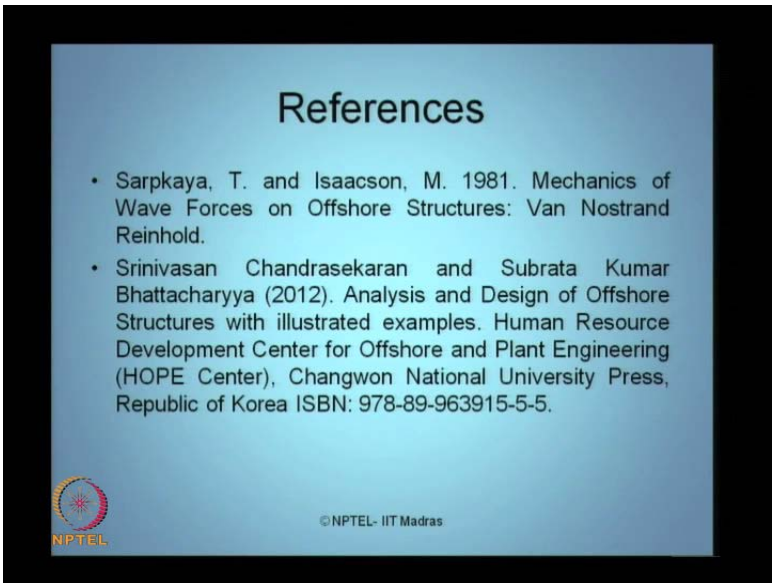

So, ladies and gentlemen, the PIC and choosy reference are indicated to you as and when we discuss. I also have a book along with my alley, SK Bhattacharyya, on analysis and design of offshore structures with illustrated examples published by Changwon national university press republic of Korea. So, all these references put together become handy for the listeners to follow the course very easily; however, the course will have detail explanation of all the points explained in the lecture itself here. You can write an email to me, we will be constantly supporting you to the NPTEL brace at NPTEL IIT Madras now.

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Let us ask a simple question can we talk about the history of offshore industry? When actually the industry started? Look at these figures, black and white photographs, specifically for you. To assign this photograph as for the understanding goals it will be at least about seventy eighty years old. You can see the type of structures which are constructed along the course. Tthere are many towers you can see. You can also see they are the most way of steel part, wooden structures and trust elements are as well you will see the extractor of offshore platform constructed to be very close, which has been very good standing illustration for the group of offshore industry in Huntington beach in California. So, one can understand that the bricks of an offshore industry actually stated in other states.

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Similar thing happened in Summerland in California. You can see many of the drilling bricks can be installed very close to the coast to be at a shallow water depths, men essentially for oil exploration. Not one, you can see many of them as a cluster being constructed and elected very close to the coast in Summerland in California.

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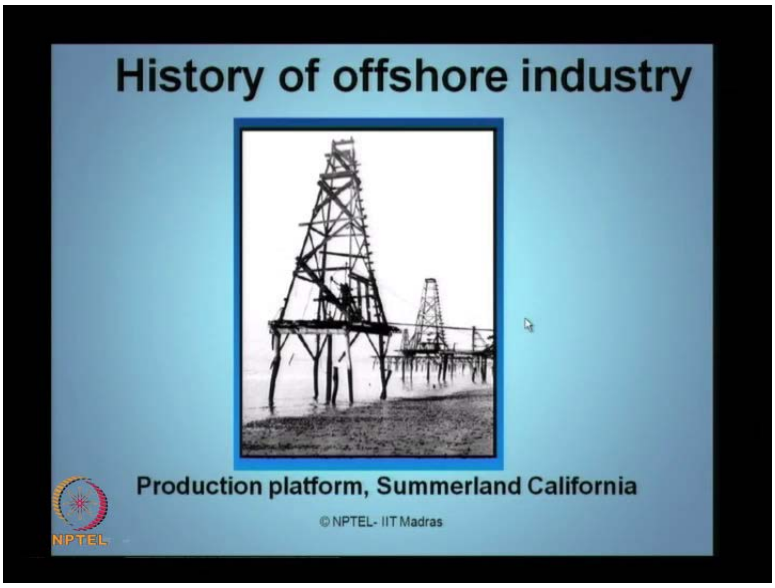

We can also see a photograph of a production platform which was simple as that which as trust system not one many of them resting on few of the legs may be six legs in this case as well it is got a depth they got a trust they got a supporting system located in a shallow depth because the structural system appears to me as very simple. So, is one of the production form which is be in photograph in Summerland California.

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Now the question comes look at this figure lake in Maracaibo Venezuela it is again a taller trust system which is having two levels depths one for operation one for

maintenance we have some inspection depths also on the higher ends and you can see some cantilever structure coming out from operation and take here essentially these are all tower form construction which are essentially a steel. So, one can see that the offshore structures as the move from the coast towards of the course you will see the height of the tower the structural complications the dimensions of the member and the size of the member all getting larger and larger as you go deeper and deeper you require a stronger structural system to encounter the environmental loads coming and acting of the structural system

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Now the fundamental question comes to mine is when this industry actually start it beginning its exploration look at an example here Caspian sea soviet era which is having up to hundred kilo meters offshore you will see the series of platforms as seen here we will also having an approach role constructed to carry the oil explore or the carry the oil generated or collected from these recourses to off course. So, people are an idea initially to construct offshore structures as for as possible closer to the coast.

When we not possible to explore oil closer to the coast people actually to move from onshore to offshore that is way this is called offshore structures. So, Caspian sea soviet era has structures closed to sea there are hundred kilo meter long offshore.

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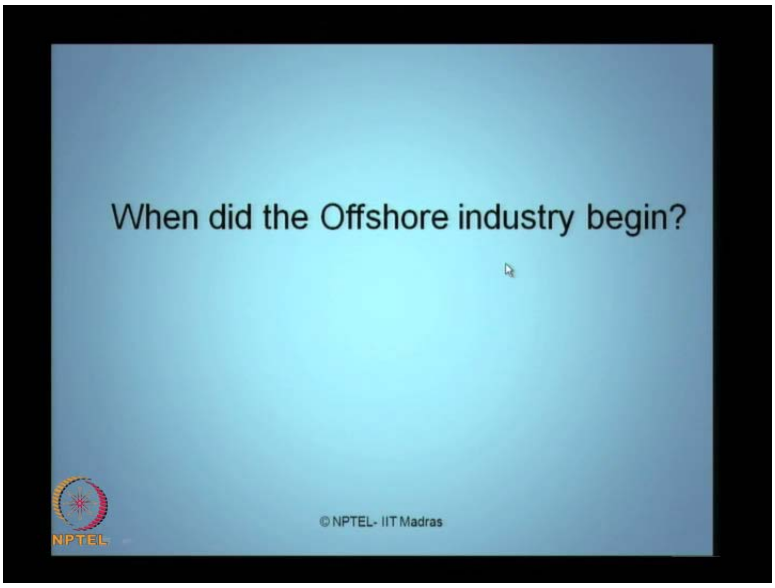

So, the question inquisitive being ask by every listener is a if at all such as old photographs as to be taken if at all see these different countries soviet union united states as contributed are started beginning oil exploitation actually when this industry at started.

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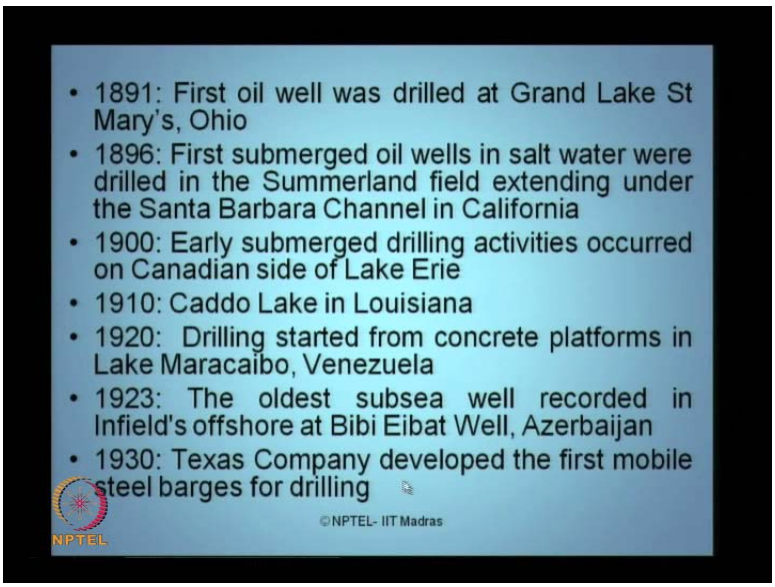

It is a very interesting question the industry started in 1891 very old a first oil well was drilled at grand lake Saint Mary' Sohio you straight 1896 first submerged oil wells in salt water were drilled in the Summerl and field I showed in the photograph of that in santa Barbara channel in California followed by which in 1900 early submerged drilling

activities started taking place in lake Erie on Canadian side 1910 Caddo lake in Louisiana at the first offshore platform 1920 the drilling started concrete structures in lake Maracaibo Venezuela which is showed a photograph 1920 three the oldest subsea well was recorded in construction in bibieibat well Azerbaijan in 1930 texas company developed the first mobile steel barges which are men for drilling and exploration of oil.

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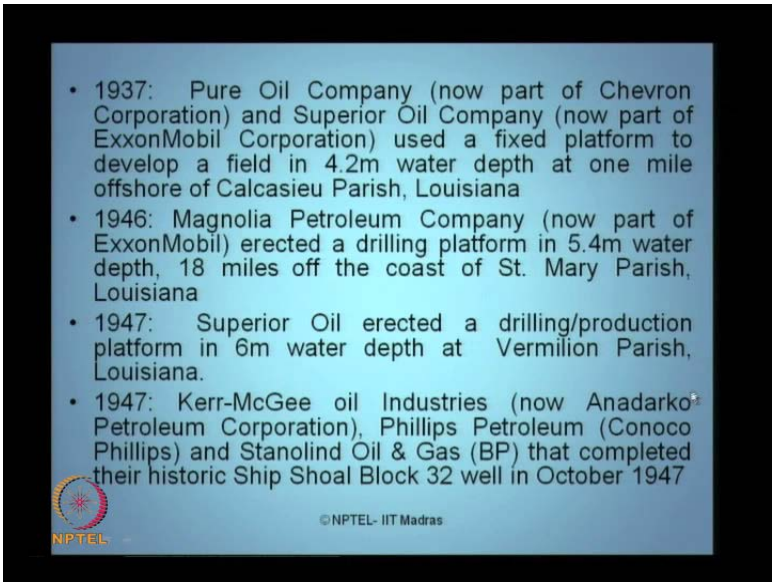

In 1937 the pure oil company now a part of chevron corporation and superior oil company we is now a part of ExxonMobil corporation used a fixed platform to develop a field at a very small depth of 4.2 meter only which is offshore at one mile from Calcasieu parish in Louisiana. So, you can the depth of water exploration was as low as 4.2 meters as an the structure was constructed as close as one mile from the beach in 1946 magnolia petroleum company which now a part of exxonmobil erected a drilling platform in depth of this 5.4 meter deep which a 18 miles off the coast of Saint Mary Parish in Louisiana 1947 superior oil erected a drilling production platform in 6 meter depth at vermilion Parish in Louisiana.

Sub oil industries which are now Anadarko petroleum corporation finished petroleum which is know Conoco Phillips stanoilind oil and gas which is bp completed in historical ship shoal block 32 well in October 1947 which is one of the major exploration of the oil industry in the country of another state.

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If we look at the statistics of the number of platforms being constructed all over the world in us especially in gulf of Mexico we got about as highest 4000 platforms as on today where is in Asia middle east Europe west Africa all put to gather would do you much lower then they are appearing in gulf of Mexico. So, one can if the summaries that offshore industry as got an dominant development in United States.

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There is a something very important to understand which we called gspr which is global strategic petroleum reserve when we talk about oil exploration first we must understand

terminology GSPR now what is the GSPR crude oil inventories hold by the government of the particular country is what we called as a global strategic petroleum reserve of a country this is called strategic reserve in financial terms this shall be used in case of any energy crisis for example, the strategic reserve in India is managed by ministry of energy this is consider as one of the important index of the net import cover of the country it means offshore industry is closely associated with the economic growth of any country because global strategic petroleum reserve is consider as an one of the important index of the net import cover of the country. So, they economy of the country which also governed by the petroleum reserve the country has what we called strategic reserve therefore, it is interesting and important for all of has to know what are the different kinds of install ration that are constructed for oil exploration all over the world as follows in India what are those technologies where available can we designed one of them for country what are the materials being used for constructing such installations how can that be maintained all these things will be discussed in these course in detail.

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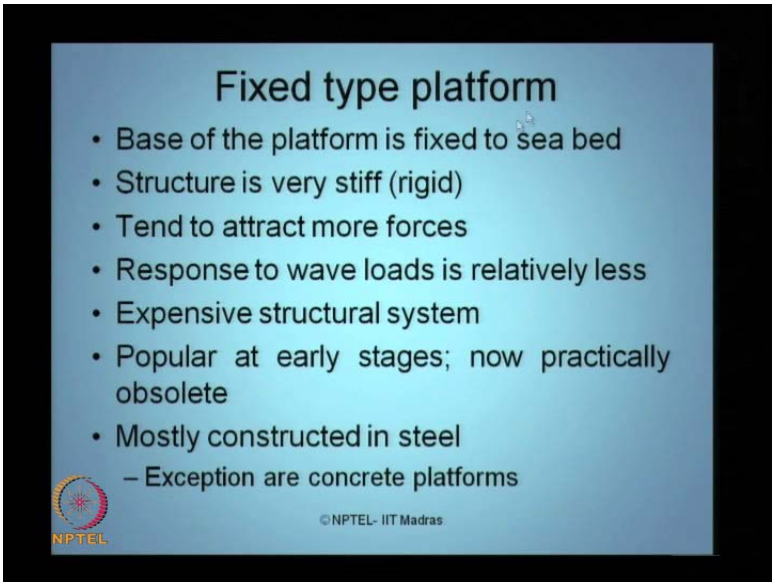

Let us slowly move on to the first kind of platform of offshore structure, which we called fixed type of platform. Ladies and gentlemen, the fundamental questions which comes to your mind could be what you have understand of the fixed type. The base of the platform or the bottom of the leg of the platform will be fixed to the seabed that is why the name fixed type appears in this category. Such structures are generally very stiff. On the other hand, the mechanical properties will cause lot of rigidity to the structure. So, because of

the stiffness imposed of the structural system, they tend to attract more environmental forces acting on them. On the other hand, alternatively, if you have the flexible system which is less stiff compare to this then the forces attracted to the offshore structures could be for lesser than the top of the stiff system, because in general stiff structures tend to attract more forces.

However, the greatest advantage is the response these forces by the platform is relatively very low. You may ask me, why? The fundamental reason is as the base of the structure is fixed to the seabed, the response of the platform to the environmental loads are very less relatively.

But, this is very great demerit in this kind of structure. They are very expensive; the structural system will be very expensive. In the early stage of oil exploration, these kind of platforms is very popular. Then now these kinds of platform are practically obsolete for oil and gas exploration because these platforms can be deployed only in shallow medium waters, unfortunately the shallow in medium waters we do not have oil deserve for exploration now. Therefore, these types of platforms are completely and practically obsolete in the presence stage. Mostly these platforms are constructed by steel as a material; however, the exceptions where such platforms are constructed using concrete as a material.

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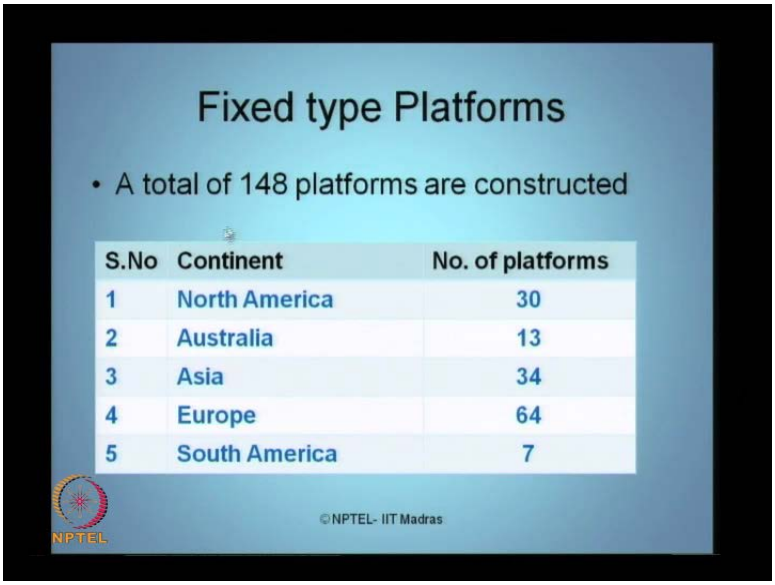

Let us look at the statistics of the different fixed type platforms constructed all over the world; about 148 platforms have been constructed as so far as per the statistics shows. In North America, you have 30; in Australia 13, in Asia is consider to be a good number of 34; whereas an south America only has an 7, where have Europe at the maximum number of fixed platforms. From the statistics, one can easily guess that US was not confident enough for investing on fixed type platforms in the larger number as that of Europe. There can be two reasons; one as we all understand fixed type platforms are (( )) uneconomical as you go for deeper waters. So, US did not want to invest on fixed type platforms because they want to go for deeper-oil exploration right from the beginning stage itself. Alternatively, Europe invested lot of amount of money in installing fixed type platforms on their shores.

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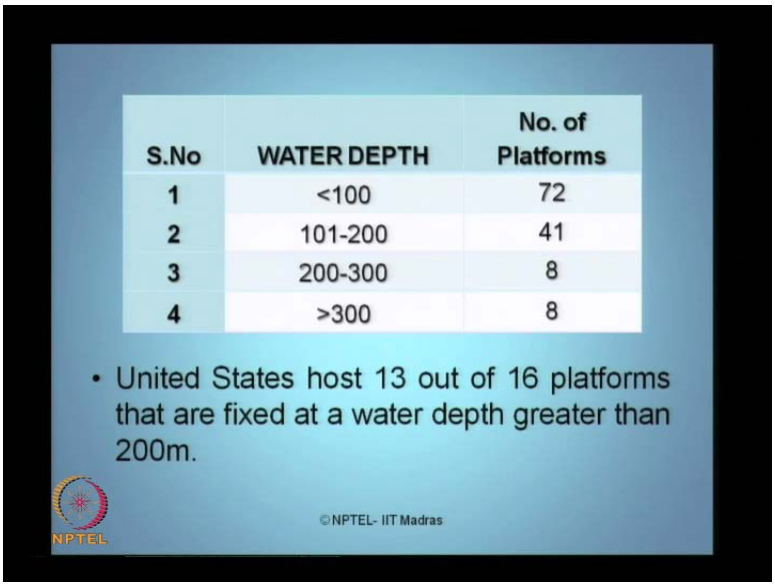

If we look at this table of categories the numbers of platforms constructed in terms of its water depth, majority of the platforms fixed type have been constructed, install, commissions and executed only at a depth less than about the 100 meters. So, less than 100 meters, they got the majority of the platforms; however, more than the seventy present total performs constructed as on today where all constructed depth up to 200 meters. So, it is seen from the table it is clearly that beyond 200 meters for example, fixed type of platforms are not attempted, because they found to be highly uneconomical. Out of these platforms US alone host 13 out of the 16 platforms that are fixed that a water depth greater than 200 meters. So, greater than 200 meters, you got about 16

platforms, out of which US alone attempted host 13 out them. Closed to 90 percent yours had tried to install fixed offshore structures at a depth more than 200 meters.

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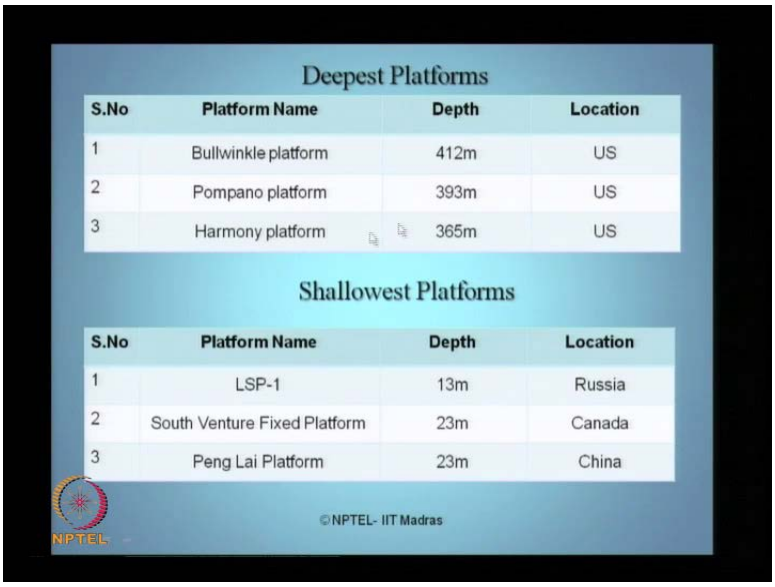

Let us look at the interesting statistics of deepest platforms and shallowest platforms. For example, deepest platforms, all of them are located in the United States – Bullwinkle, Pompano and Harmony at different water depth as seen in the table. The shallowest platforms where never installed in US, because United States had in utilization of deep water oil exploitation like from the day of beginning of the oil exploration, we are attempted to design structures at higher water depths. Whereas we look at the comparison of the water depth, where structures constructed in US compared that of other structures constructed elsewhere, there only about 25 meters where are they are at least about 20 times of these depths. So, US had always a flavors for (( )) structures at deeper water depths.

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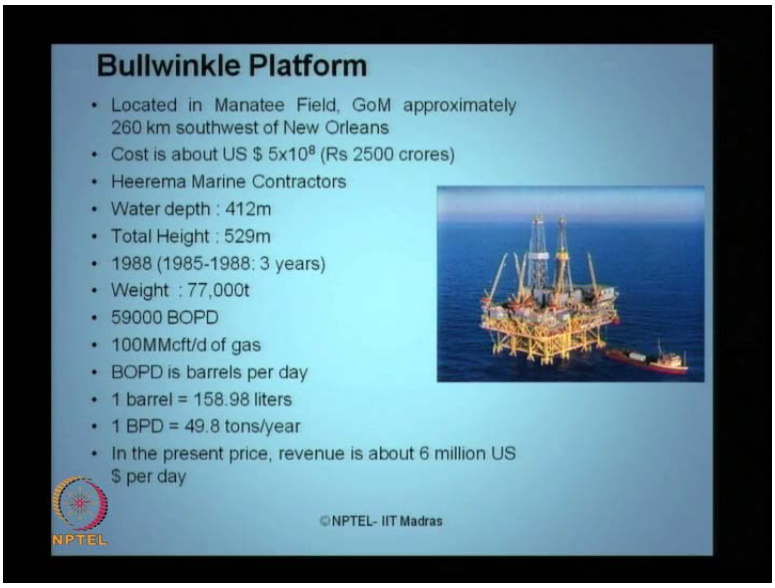

Let us quickly look at the over view of difference kinds of platforms constructed in US for the deepest waters. Bullwinkle platform is a photograph what you see here. Located in Manatee Field, Gulf of Mexico, approximately 260 kilo meters southwest of New Orleans. The cost of this platform then constructed about 2500 crores Indian rupee; costing about 5 into 10 power 8 US dollars approximately. Heerema marine contractors construct these platforms at a depth of 4112 meters. The total height of the platform is about 529 meters, the water depth is 412 is about 110 meters is the top side height what you see here. Constructed in the year 1988, it took about three years contractor to complete the platform. The total weight of the structure is about 77,000 metric tons. It produce about 59,000 BOPD.

Now the question comes is what we understand by the term BOPD. It also produced about 100 MMcft per d of gas. BOPD is expressed as barrels per day; one barrels about 158.98 liters. One BPD is about closed to 50 tons in year that the statistics of oil production. In the present price, for example, if you want to understand the figure, financially, the revenue, which this platform could get to the US is about 6 millions US dollars in one day, that is the revenue of this platform. Now imagine, commercial value of offshore platform structures when they are commissioned in any sequenced, they are very high.

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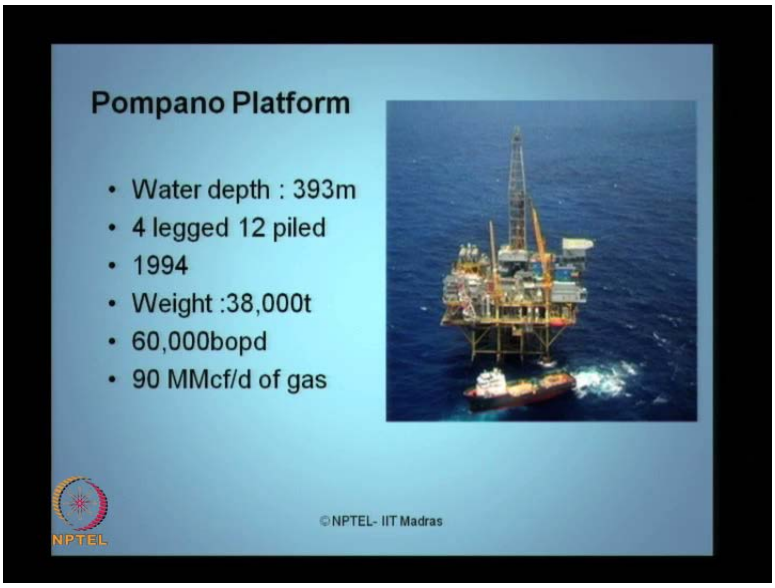

Let us look at the next platform. The photograph shows here a pompano platform; constructed at the water depth of 393 meters. It rest on four legged, 12 piled structural system; constructed in the year 1994. The total weight of the structure is about 38,000 tons, and this produced about 60,000 BOPD, which is equivalent to 90 MMcf per d of gas

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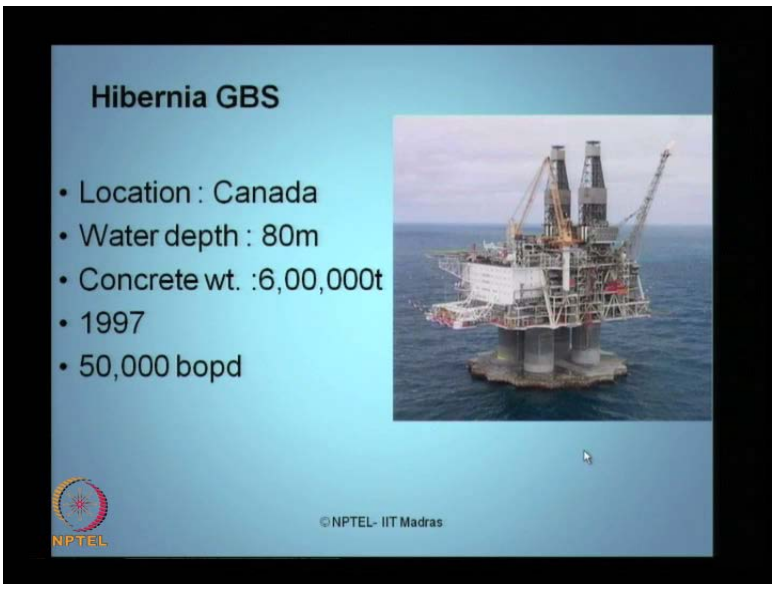

Hibernia gravity based structure is another example located in Canada at a depth of 80 meters. It is a concrete platform, the concrete weight alone is above 6 into 10 power 5 tons, some massive construction systems build in 1997, produced about 50,000 BOPD.

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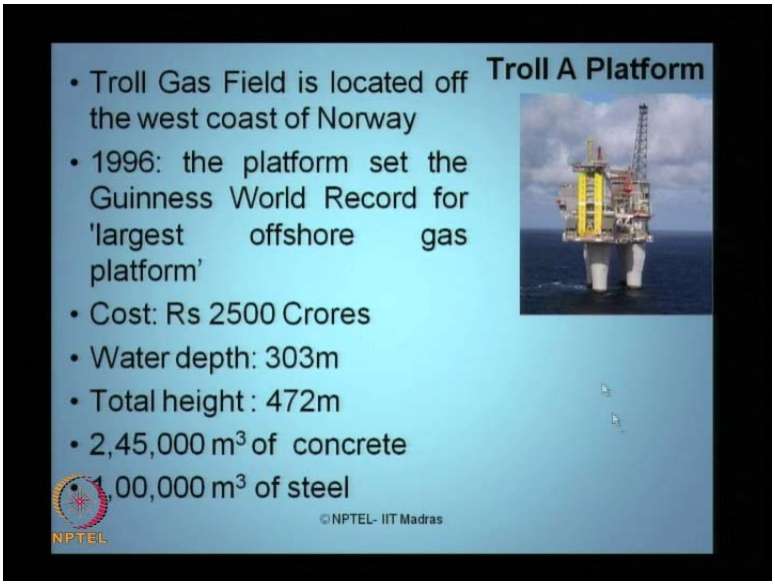

The next platform what we see here is a troll A platform. The troll gas field is located off coast of Norway in the western coast of Norway. In 1996, the platform set a Guinness world record for being the largest offshore gas platform in the world. It cost is about 2500 crores Indian rupee at the time in 1996. It is constructed at the water depth of 303 meters; the total height of the platform is about 472 meters. So, 472 minus 303 about 150, a 160 a meter is a top side height of the platform. It has about 245 into 10 power 3 cubic meters of concrete can imagine the depth feet of the concrete of the platform, and it as used 110 power 5 cubic meter of steel for its construction that is a very amazing statistics this platform has.

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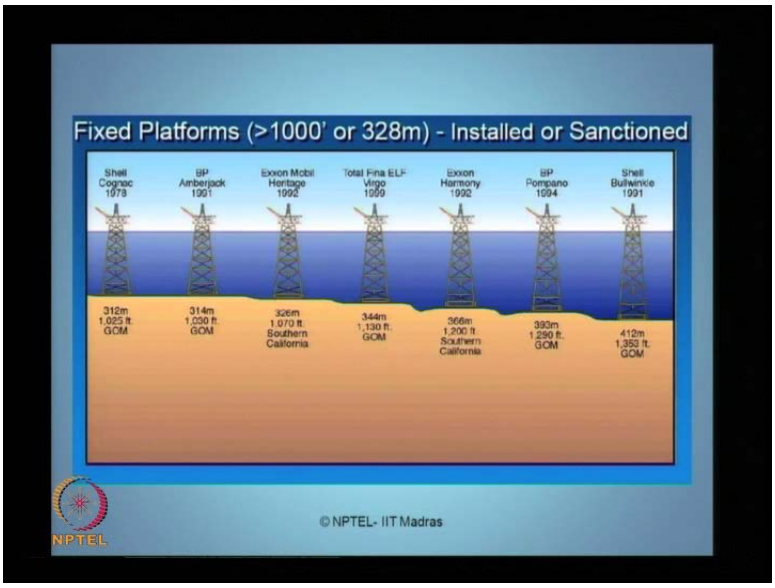

This figure shows a very comprehensive look out of different fixed platforms constructed above 328 meters at Shell Cognac, 1978. BP Amberjack, Exxon Mobil Heritage, Total Fina ELF Virgo, Exxon Harmony, BP Pompano, Shell Bullwinkle, the year of construction is shown here. It is been indicated the increasing water depth, starting from 312 meter, the water depth of the construction status increasing and went as deep as 412 meter in Gulf of Mexico for fixed platforms, as the deepest fixed platform the available in the record.

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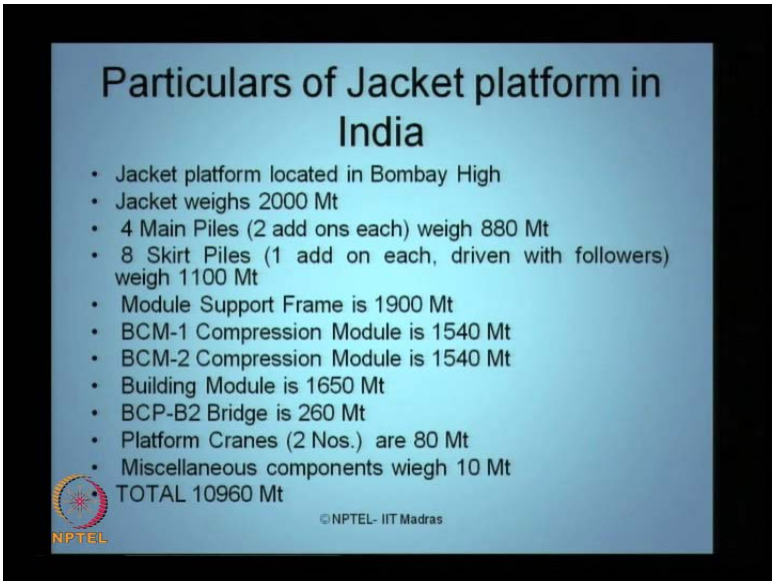

We also have jacket platform constructed in India, in Bombay High. The jacket weighs about 2000 metric tons, resting on four main piles, 8 skirt piles, module support frame weighing about 1900 metric tons and the compression module one, two weighs about 1540 metric tons each. The building module weighs about 1650 metric tons constructing a total of weight of about 10960 metric tons in total.

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This is the photograph of the jacket fabrication of this platform.

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There are some photographs about the jacket transport.

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These are some photographs on installing the jacket structures. We will discuss about the installation process in detail in the coming lectures.

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This is the process what we call as upending that is erecting the leg from on towing position to the upright position.

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Main piles are getting installed for supporting the deck.

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These are some internal lifting tool being used for erection.

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These are the some photograph of during the welding of the piles or the members.

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Now, the deck is being transported which is pre fabricated transported to get placed in position for the platforms.

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After the whole deck has being built on the building module are erected and commission the whole plat form is now ready as you see here.

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The plat form is now complete is what we have one of the classical jacket structures, which is fixed offshore structure in Bombay High Court.

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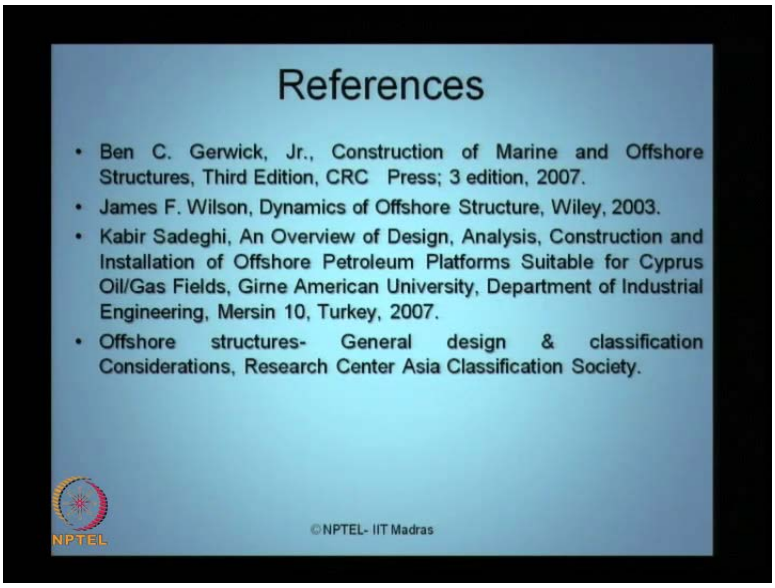

So, in this lecture, in this course, we will have selected references which are list down here. Of course, the detail references and the research papers, which will concern for this course are already available in the website at NPTEL, IIT Madras. Some of the interesting references I want to read are the following, which has been shown in the slide now. Ben Gerwick, Construction of Marine and Offshore Structures; James Wilson, Dynamic of Offshore Structure; Kabir Sadeghi, An Overview of Design, Analysis, Construction and Installation of Offshore Production Platform. Offshore structures - General design and classification considerations is given by Research Center Classification Society and so on. In the next lecture, we will talk about fixed type offshore platforms; we will speak about gravity platforms.

Thank you.