Computer Methods of Analysis of Offshore Structures

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Module – 02
Lecture – 01
Offshore structures - 1

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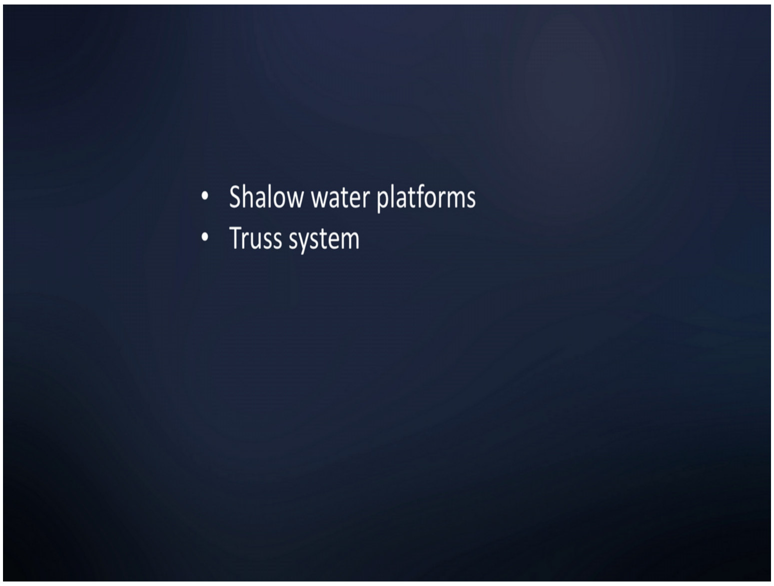

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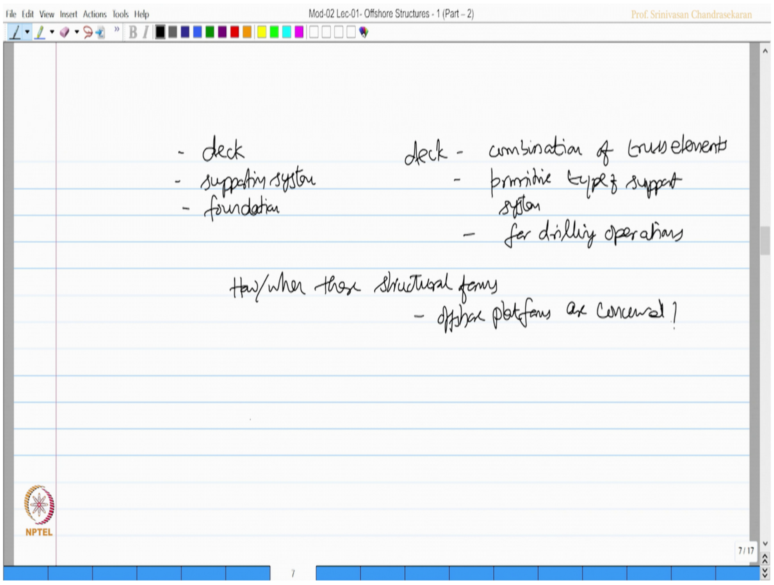

So, let us see that first; most of the common structural forms consist of deck, supporting system, a foundation etcetera. If you talk about deck; usually it is combination of truss elements essentially; they offer more primitive type of support system, because the support system, what you need is essentially for drilling operations. So, we need only that primitive support system which can offer some resistance during drilling operation.

One may wonder how this structural forms where originally conceived? How or let us say when these structural forms for offshore platforms are conceived? When they started coming into play?

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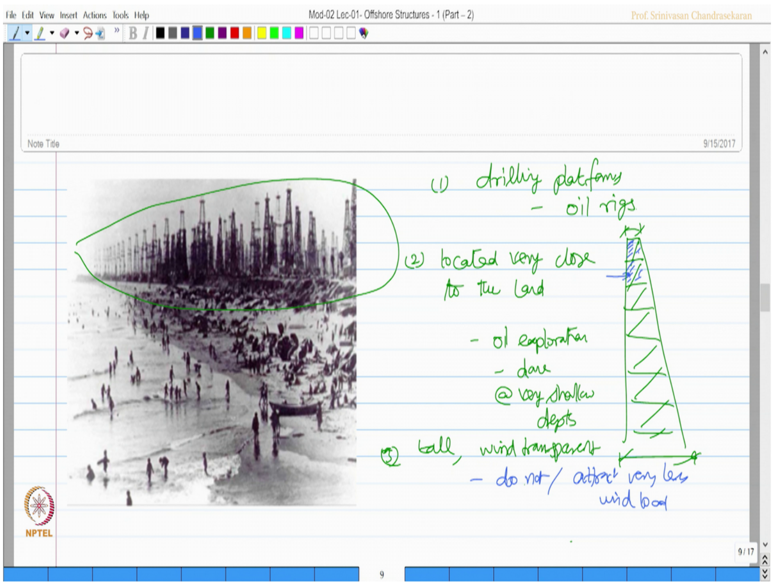

If you look at the picture here which is available on the screen it is a black and white photograph. We can see the drilling ricks what you see along the coast line essentially depict a very common form.

One observation what you make from this figure is that; the drilling platforms which are otherwise in Layman's language they are essentially of a truss type. You can see here the second observation we can make is most of them were located very close to the beach or I should say to the land you can see people are on the coastal side and they are located very close; obviously, one can expect that oil exploration was actually taken or done at very shallow depth.

One can also see a trapezoidal configuration, where the top side is lesser than the bottom. We can see in almost all the cases it is true. So, they are very tall wind transparent what you mean by wind transparent? It means the surfaces what you see here these surfaces they enable passage of wind; wind passes through them the moment you have a system which is wind transparent it is sure that they do not or they attract very less wind load ok.

So, that was the original idea for drilling platforms which are essentially meant at shallow depths by the way this photograph shows Huntington beach in California where oil exploration started about approximately 100 years back. So, a common configuration which was found to be effective for shallow water oil and gas exploration was a truss based system essentially material is steel or sometimes even wood. The geometric form is a very simple that is why I said they have primitive support systems ok.

So, that is what I am writing here they have very primitive support system that was the original idea.

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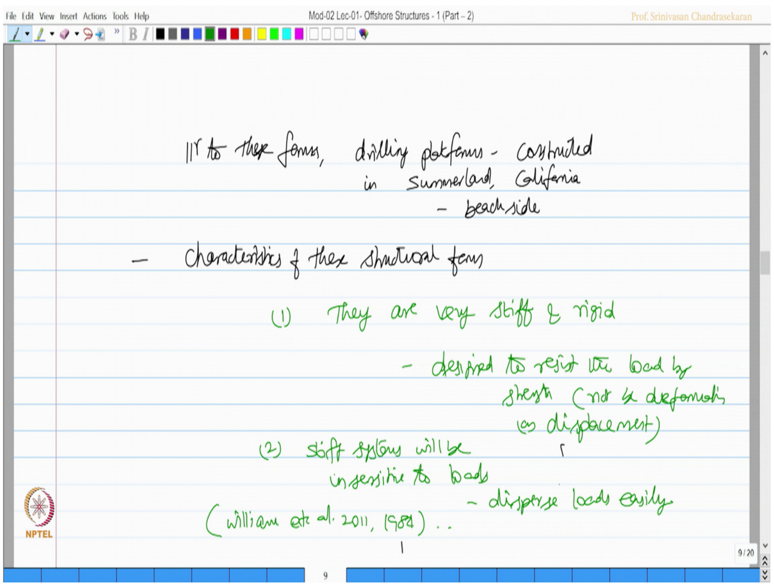

When offshore drilling platforms are actually originally conceived about 100 years back. Similar to this similar to these forms, drilling platforms were constructed in Summerland, California all along the beach side. So, there are some important characteristics of these structural forms. Let us see what are they. One they are very stiff and rigid; it means initially they were designed to resist the load by strength.

Not by deformation or displacement, that is the original idea, why? Because it is believed that stiff systems will be insensitive to loads. They can disperse the loads easily that is the original idea you can see in the design. Of course, the statement was verified by many researchers as an example William et al in 2011, 1984 stated that stiff systems will generally attract loads and disperse them easily making them insensitive for load dispersion.

So, initially people thought offshore systems will have stiff geometry with high level of rigidity and they will resist the loads essentially by strength and not by displacement.

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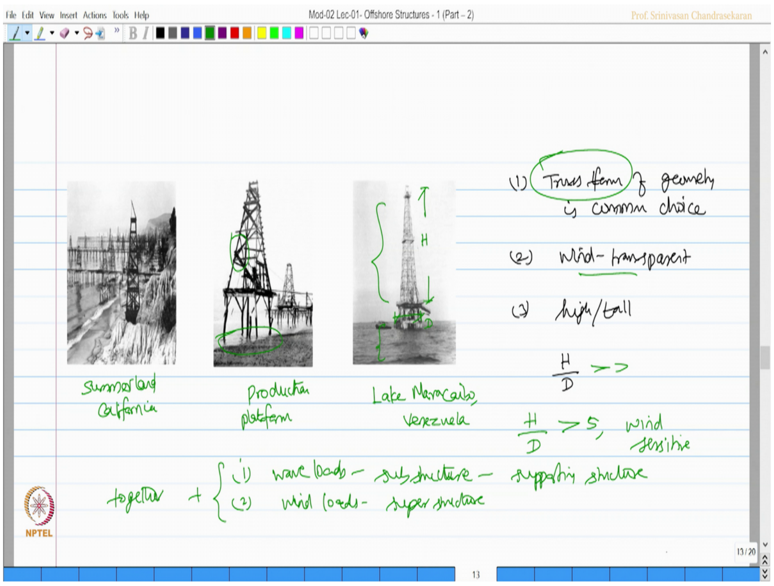

If you look at the photograph shown on the picture now this is the typical offshore drilling derrick which is in summerland California; this is essentially retail of the production platform in summerland and this is again an offshore drilling platform constructed in lake Maracaibo Venezuela.

So, now we can do some common observations of all these kinds of platforms. One the truss form of geometry is the common choice you can see that here. Secondly, they are wind transparent. third they are very high that is tall, the H by D that is if it take this dimension the base dimension as D and it take this dimension as H; H by D is very very high. So, initially we all agree that if H by the base dimension is more than 5 they are considered to be wind insensitive. So, offshore platforms essentially had wave loads at the substructure or I should say wave loads act on the supporting structure.

For example; you see here these legs will attract wave loads whereas, wind loads are predominant on the superstructure. Superstructure is one above water and sub structure is one which is below water. So, two combination of loads start acting together in offshore platforms essentially they were considered to be stiff and rigid and people believe that stiff and rigid systems are insensitive to disperse loads acting on them they were made essentially wind transparent, they have very high H by D ratio and the geometric form essentially of a truss type, which consists of members both diagonal and axial; which is the very common form in trusses having said this.

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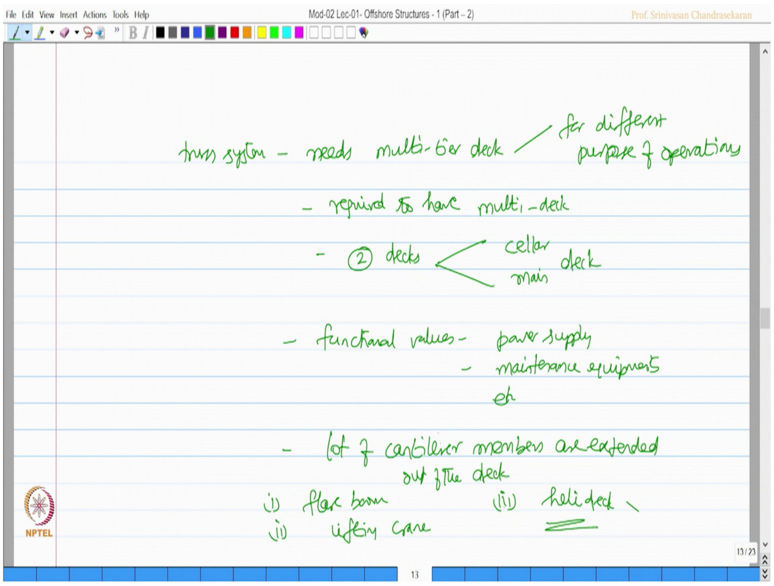

We can how make a statement; the truss system needs multi-tier deck for different purpose of operation. So, offshore platforms are essentially required to be required to have multi deck. Initially they were constructed with two decks, one is what we called the cellar deck and the main deck, which are need to look after the functional values, like power supply, maintenance equipments, etcetera.

One can also see in these figures, that they were lot of cantilever structures are extended out of the deck for various purposes. One such important arrangement was the flare boom.

The second could be a lifting crane; the third of course, which letter on developed is heli deck etcetera. So, now, we have a combination of a truss type system which is rigid and stiff which has cantilever members extending and this form was found to be common for structures where shallow water exploration used to happen about 100 years back.

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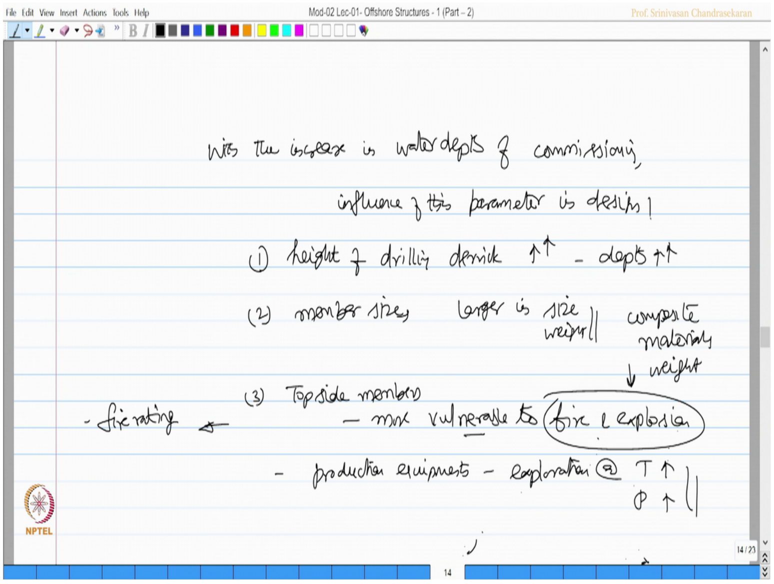

So, as we all agree as structural engineers with the increase in depth, with the increasing in water depth of commissioning; what would be the effect? What would be the influence of this? Parameter in design, because we would like to know this the height of the drilling derrick, number 2 because the drilling derrick height will be keep on increasing. The second could be the cross sectional member sizes, they will become larger in both size and weight one can also use of course, composite materials to reduce the weight etcetera.

Thirdly, you see the top side members are more susceptible or more vulnerable to fire; an explosion, because they house lot of production, equipments, which we drew exploration at high temperature and high pressure. So, this can also land up in vulnerability to fire and explosion. So, these members should be also having to be designed for fire rating, that is a requirement now which is gradually coming up as you proceed this for greater water depths with large size of oil and gas production. So, we have a basic inference what we obtain now.

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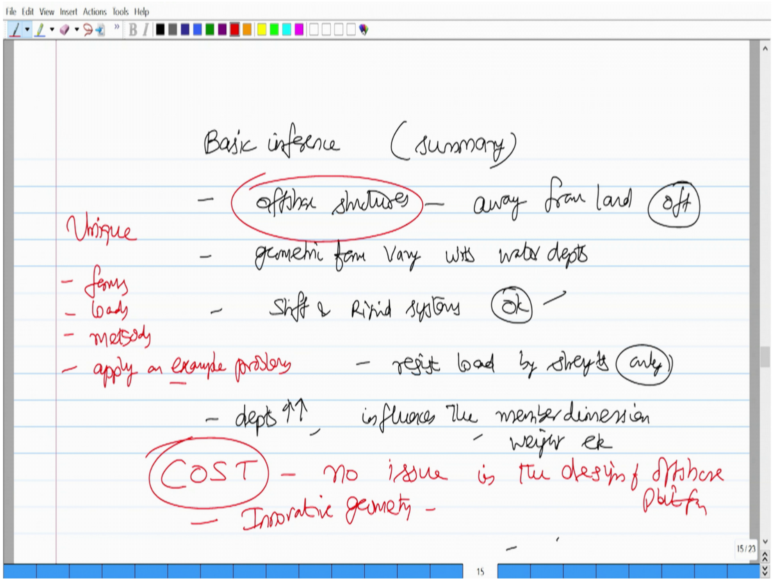

Which is also going to be summary now of this lecture? We understood that offshore structures are constructed away from the land.

So, the term off indicates away from the land; essentially the geometric form vary with water depth. Initially, people thought stiff and rigid systems are they are design to resist loads by strength only I should say; as the water depth increased people realize that it influences the member dimensions weight of the platform etcetera. Please understand friends; cost was no issue in the design of offshore platforms, but when you pay more were innovative geometry cost naturally used be high. Therefore, in simple terms we can say offshore structures are unique. To do an analysis of these kinds of structural systems we need to understand different structural forms, different loads acting on the structural forms. Then will talk about methods of analysis. Then we will apply them on example problems and learn the analysis that is the idea which we will see in the next lecture.

Thank you very much.