Computer Methods of Analysis of Offshore Structures
Prof. Srinivasan Chandrasekaran
Department of Ocean Engineering
Indian Institute of Technology, Madras

Module – 02
Application to Offshore Structures
Lecture – 01
Offshore Structures – 1 (Part – 1)

Welcome to the set of lectures in second module. In second module of the course titled computer methods of structural analysis of offshore structures. We are going to focus on application of computer methods of structural analysis with examples taken from offshore structures, before we do detailed analysis on offshore structures. Let us find few lectures on understanding different structural forms of offshore structures, their function and importance of the structural action under the given environmental loads.

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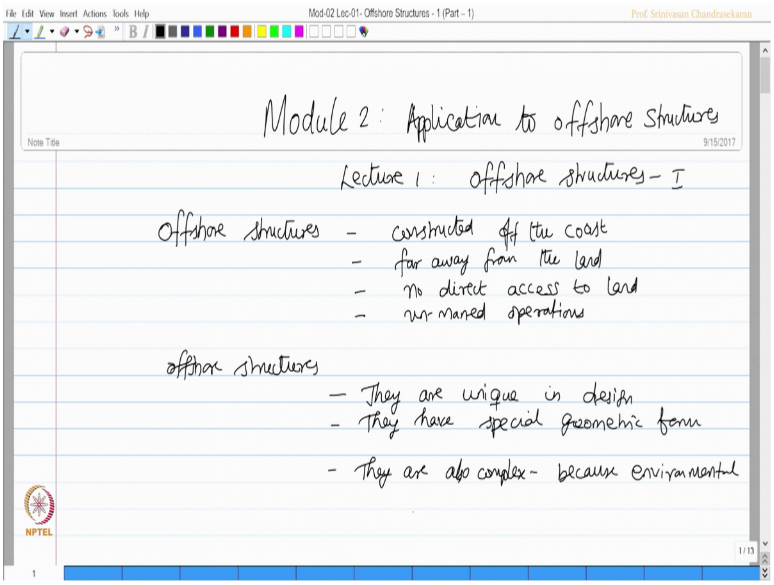

So, lecture 1 in module 2 is going to focus on varieties of offshore structures part 1. Friends; offshore structures are actually you constructed off the coast, far away from the land, they have no direct access to land, sometime this platforms can even be subjected to unmanned operation. Now offshore structures have some special characteristics. First of all I should say they are unique in design.

Secondly, they have special geometric form which needs to be understood before we do a detailed analysis. Further, they are also complex, because the environmental loads act on them.

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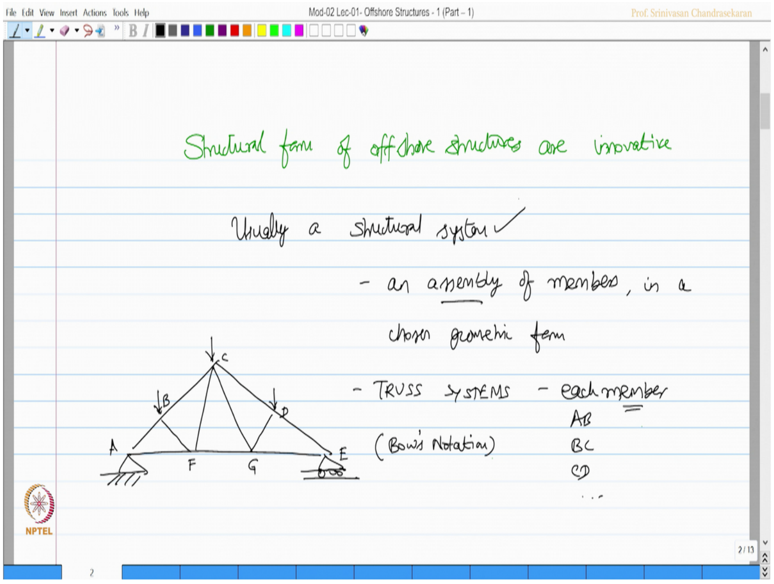

Now, I should say an important point the structural form of offshore structures are very innovative. Friends; when you talk about the system which is usually designed to resist loads, a structural system which is an assembly of members in a chosen geometric form.

I can give an example let us take truss systems. So, I have a truss system. It will have some support condition; let us say a simply supported truss subjected to some loading at the nodes. Now, I could say this as a structural system, because of simple reason if I start naming the joints as A, B, C, D, E, F and G by using what we call as Bows notation, each member for example, A B, B C, C D and so on.

There all each members which are assembled in a specific form to form a system. So, structural system usually, is an assembly of members in a chosen geometric form which is meant to resist the applied load, essentially by its strength. So, I insist the word essentially it resists the load by its strength, but friends when you talk about assembly of members in a geometric form in offshore structures.

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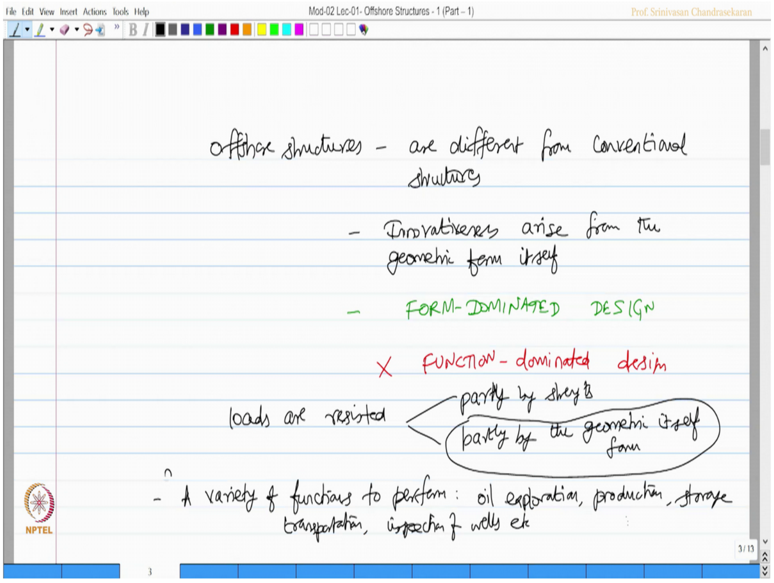

Offshore structures are slightly different from that of conventional structures, because the innovativeness arises, from the geometric form itself. So, I should say a single word which is the captive word in offshore structural design, it is actually form dominated design. It is not a function dominated design.

Essentially loads are resisted: partly by strength, partly by the geometric form itself that is very interesting. So, this particular character makes offshore structures different from the other conventional structures. So, we need to understand, how a form dominance essentially resists the loads? To now understand the statement we need to understand different types of offshore structures, before we proceed with the analysis of these structural systems. In addition, they have a variety of functions to perform to name a few oil, exploration, production, storage, even transportation, inspection of wells, etcetera.

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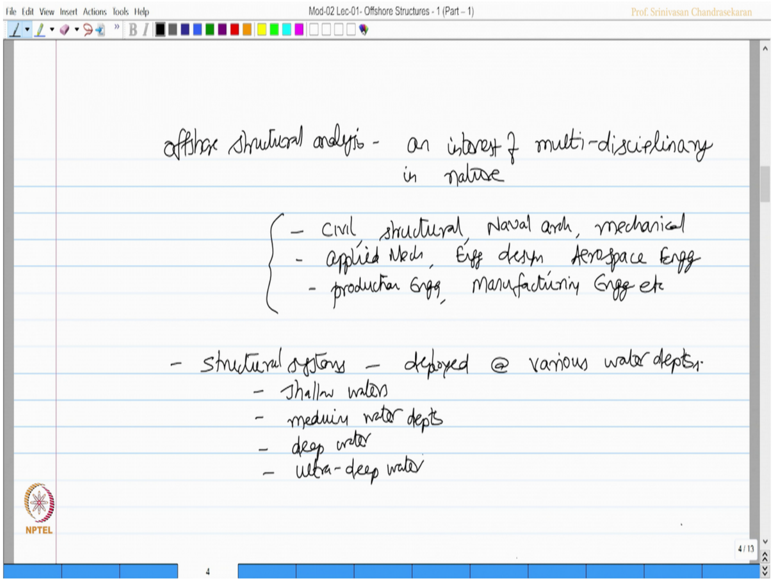

There are varieties of functions which an offshore structure generally perform, so one can now say; offshore structural analysis is an interest of multidisciplinary in nature. This will attract listeners from civil engineering background, structural engineering background, naval architecture, mechanical engineering, applied mechanics, engineering design, aerospace engineering, production engineering, manufacturing engineering, etcetera. So, we cannot really address multidisciplinary terminologies which are common to so many interdisciplinary subjects and focus of interest.

So, we will try to orient, the lecture in such a manner that simple terms used in analysis can be understood by engineers of the following background as just now mentioned. So, offshore structural systems are essentially deployed, at various water depths, because friends as you go away from the coast towards the mid-sea the water depth in ocean keeps on varying. As you correctly guessed, water depth near the coast will be very shallow as you move far away from the coast towards the mid-sea it will become deeper and deeper.

So, offshore structural systems are deployed at shallow waters, medium waters or medium water depth, deep water and ultra deep water. So, now, I throw a question to you for your understanding.

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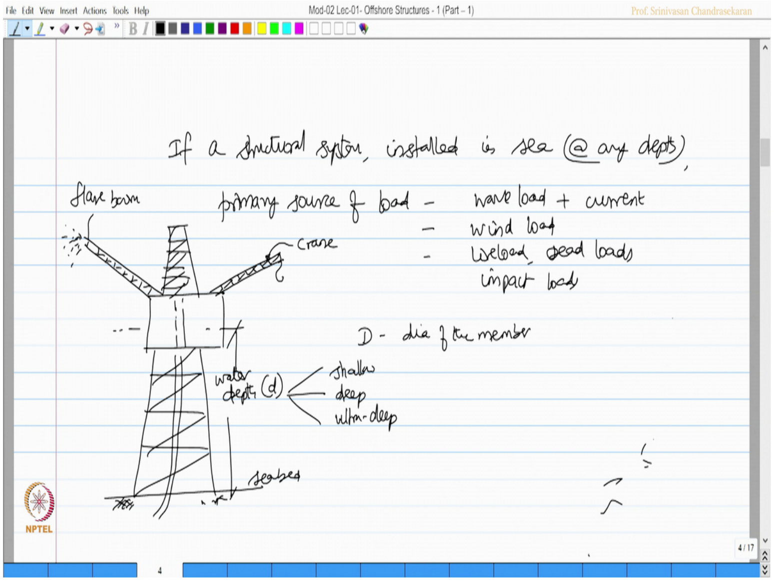

If a structural system which is to be installed in sea, the primary source of loading act on this will be wave loads; will also add with the current present in ocean. Further it will also attract lot of wind loads; in addition it may attract of course, live loads, dead loads impact loads etcetera.

Let us take a system which will have some topside data in which will have may be a crane, may be a flare boom. So, crane, flare boom and some drilling derrick, which will pass through the platform to have some drilling operation, let us say this is my sea bed. Now this platform will have some portion of draft immersed in water and I call now this as water depth; indicated by small d, because capital D will indicate diameter of the members that is the common nomenclature people use. Now as the water depth keeps on increasing from shallow to deep to ultra deep, you will realize that the same support system which you have planned for this will not hold good for a deeper system.

So, on the other hand the structural system or the geometry of the system strongly depends on the water depth and sea state of operation.

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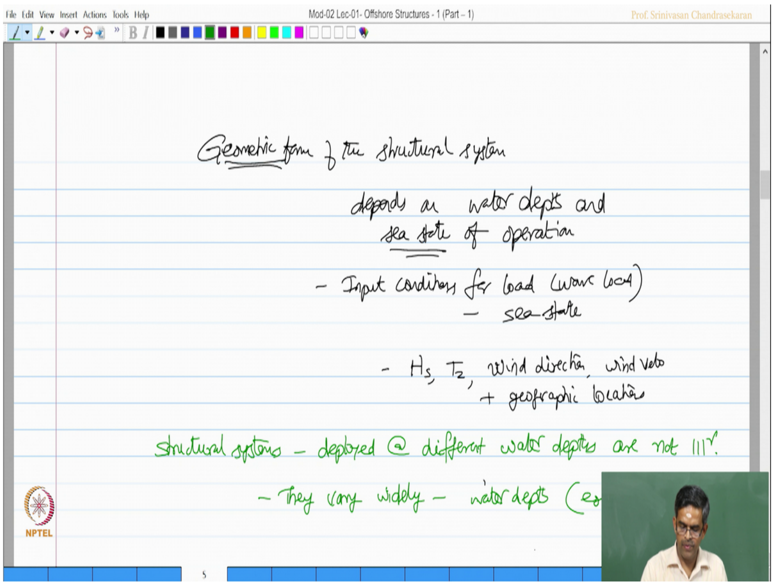

Generally, in analysis and design of offshore structures; the input conditions for loading especially for wave load are given in terms of sea states. Sea state will include the wave height, the period of the wave, then the wind direction, wind velocity; in addition to the geographic locations etcetera. So, depending upon the sea state, where you want to commission the platform the geometric form will be different.

So, now let us see what are the various geometric forms or configurations which are used in offshore structures for oil exploration. One important statement which will make you interesting is that; the structural systems deployed at different water depths are not similar. They vary widely depending upon the water depth essentially fundamentally water depth will make the structural system to vary.

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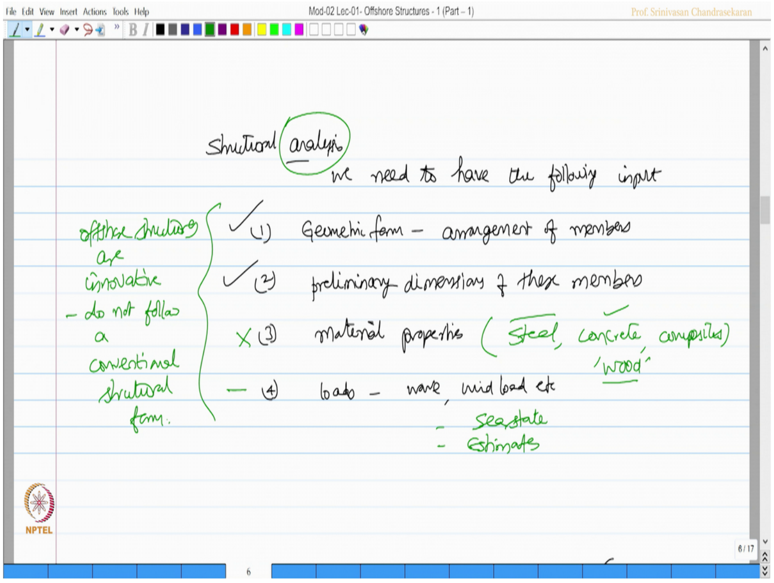

Now to understand how a geometric form can be conceived, because to do a structural analysis, we need to have the following information, we need to have the following input.

You need to have essentially; a geometric form which shows arrangement of members, you should also know the preliminary dimensions of these members, one should also have an idea about the material properties, one should of course, have an idea about the environmental loads like wave load, wind load, etcetera which we will discuss in detail in this module. So, let us pick up one by one slowly. To do an analysis, I need to know the geometric form and the preliminary dimension. Let us take for example, the most commonly used material is steel, concrete. And now in the recent times people also use composites. Wood has being used is also being used, but a rare application; generally offshore structures are primarily constructed with steel as the material. We do have concrete platforms as well. So, material is not a serious botheration for the analysis perspective; loads will be defined by the sea state. So, we should know how to estimate these loads for the analysis.

The main problem starts with what geometric form I have to assume for the analysis. As you essentially said offshore structures are innovative, do not follow a conventional structural form; hence we should have an idea about the geometric form of platforms which also varies with depth.