Computer Methods of Analysis of Offshore Structures

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Module – 02
Lecture – 07
Environmental Loads – 1 (Part – 01)

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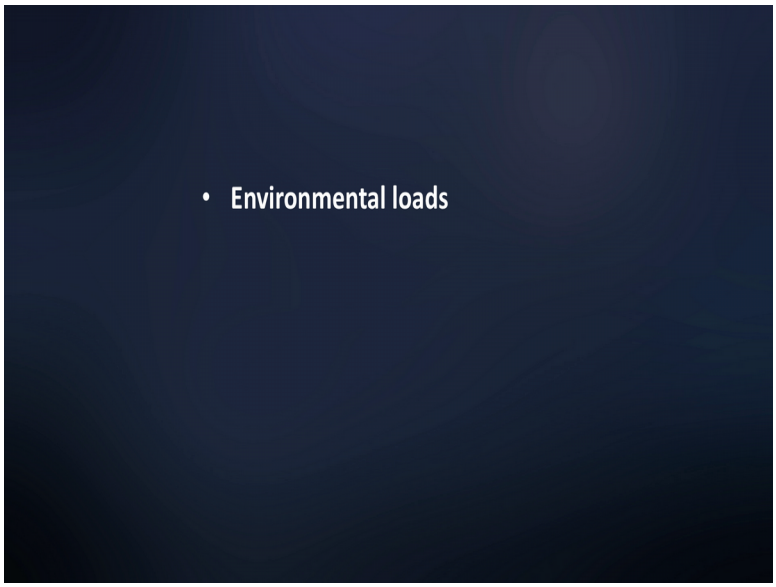

Friends, let us continue with the discussions on module 2. Where, we will talk about some computer coding to estimate environmental forces on offshore structures. Before we understand how to write a coding to estimate forces and loads on offshore structures let us have a general understanding of various environmental loads the act on offshore structures.

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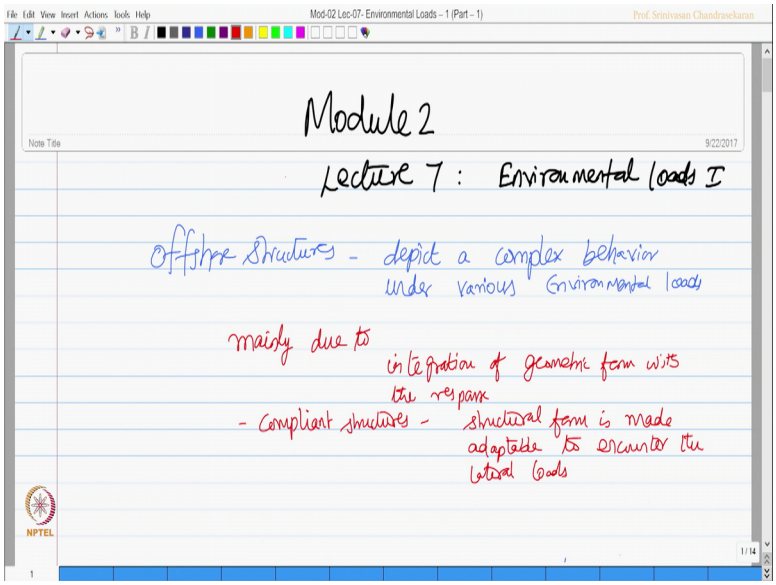

We have an idea of making a statement that offshore structures depict a complex behavior under various environmental loads.

This is mainly due to integration of geometric form with the response. In fact, if you really see behavior of compliant structures one can realize that the structural form is made adaptable to encounter the lateral loads: number one.

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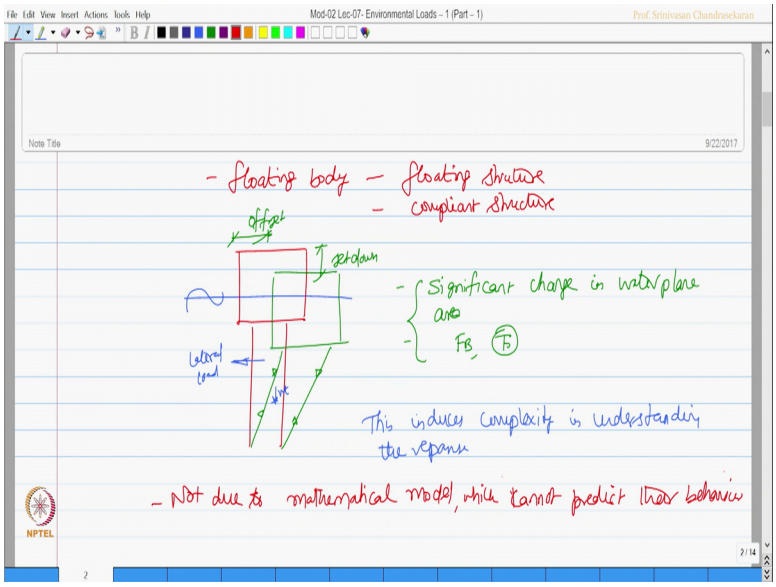

Number two: if you take a floating body, in fact a floating structure or a compliant structure say a TLP. TLP undergoes displacement and deformation which has offset and

set down. This induces a significant change in water plane area, and that changes the buoyancy force. And therefore, it can change the dynamic tension variation in the tethers.

On the other hand, the response nature of the structural system actually encounters or opposes the encountered load: the horizontal component and the vertical component of the tether tension variation takes care of the lateral load and adds to the weight in turn which improves stability. So, it is very important to understand the statement that structural form is made adaptable to encounter the environmental loads.

So this induces, this behavior induces complexity in understanding the response. Please note the complexity is not due to the mathematical models which cannot predict the behavior. So, loads can be defined with the higher accuracy, but the complexities essentially arise from the interconnecting nature of the geometric form with the load. So, that is the problem here.

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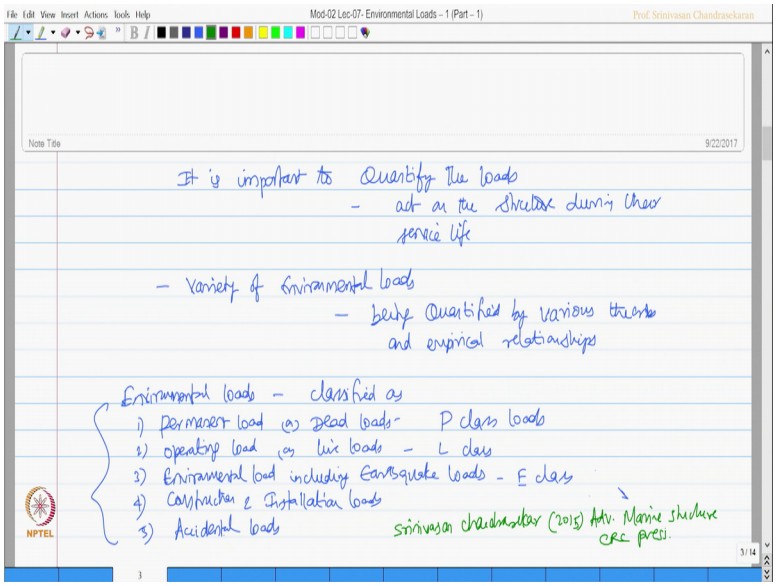

Having said this, it is therefore important to quantify the loads that act on the structure during the service life. Now, there are variety of environmental loads which are been quantified by various theories and empirical relationships. So, we will discuss one by one and try to understand how to quantify these loads based on various theories.

Environmental loads which act on offshore structure can be classified as permanent load or dead loads. They are called as P class loads. The other form is operating loads, they

are also called as live loads, they are called as L class, other is environmental loads including earthquake loads. So, that is very important in ordinary class of structures earthquake loads are considered to be special loads, whereas in offshore structure analysis earthquake loads are part of environmental loads E class loads. Fourthly, construction and installation loads, and lastly accidental loads.

Details of these can be seen also in Srinivasan Chandrasekaran in 2015 Advance Marine Structures CRC press.

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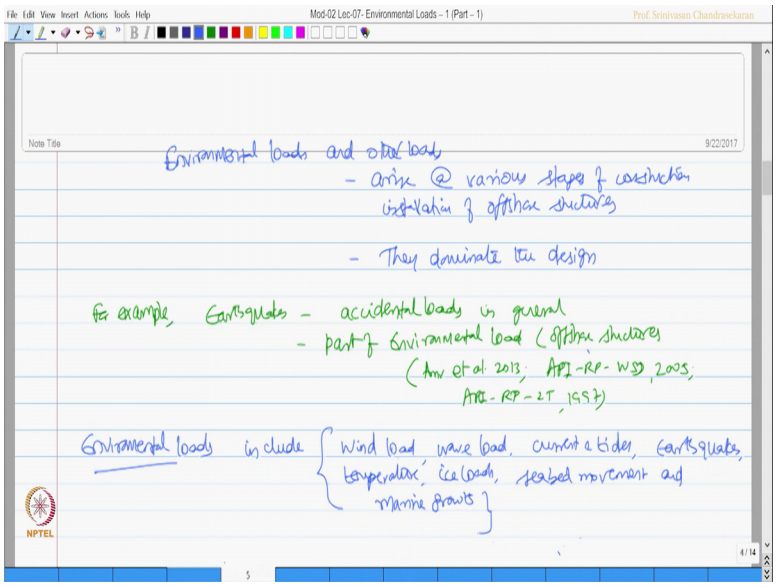

So, let us realize that environmental loads and other loads they arise at various stages of construction installation of offshore structures. Therefore, they dominate the design. For example, earthquakes are considered to be accidental loads in general. But it is a part of environmental load in offshore structures. We can see this at Amar et al 2013, API-RP-WSD 2005, API-RP 2T 1997 etcetera.

Then the question comes what are all included in environmental loads. Environmental loads include wind load, wave load, load from currents and tides, earthquakes, temperature loads, ice loads, sea bed movement, and loads caused by marine growth. So, it is a large subset.

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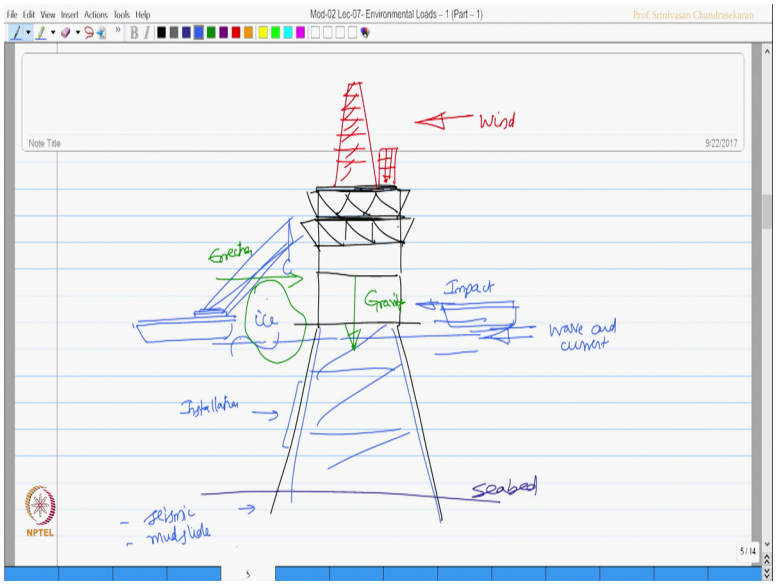

If you look at the typical let us say an offshore platform with multitier deck. Let us say seabed, here the loading will be occurring because of seismic, it can also be because of mudslide. In this range let say, this is my water level. So, this can be subjected to maybe this an installation jacket and these are all, I can have loads of installation type in these members. Loads from wave and wind may act in this region. Wave and current may act in this region. Loads from ice can also act in this region.

Of course dead weight which we call gravity loads will act here. It may be subjected to some installation let say- I have a barge; the barge has an installation platform. Then I have erection loads here, I have wind loads which essentially come from the derrick members, living quarters. So, in this region I may have wind loads, and when there is a barge I may have impact loads.

So, this slide gives you a combination of various kinds of environmental loads that are typically acting on an offshore structure.

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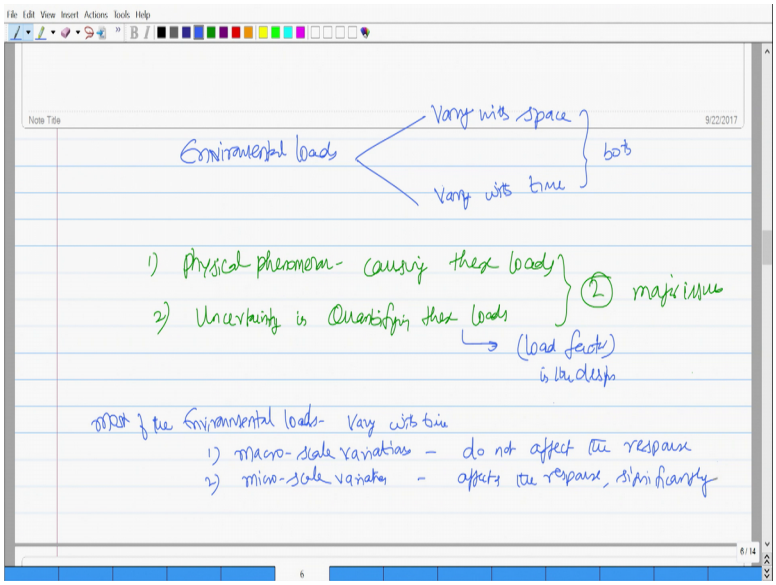

Having said this, we now agree that environmental loads have actually two components: one, vary with space other varies with time; sometimes they may vary both.

So, interestingly physical phenomenon causing these loads and uncertainty in quantifying these loads: are two major issues. Of course, to some extent this issue is handled by using something called load factor in the design. It is also important to know most of the environmental loads vary with time and this variation can be a macro scale variation, which do not affect the structural response. Two, it can be a micro scale variation which will affect the structural response significantly.