Computer Methods of Analysis of Offshore Structures
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Module - 02
Lecture – 09
Wind Loads (Part – 2)

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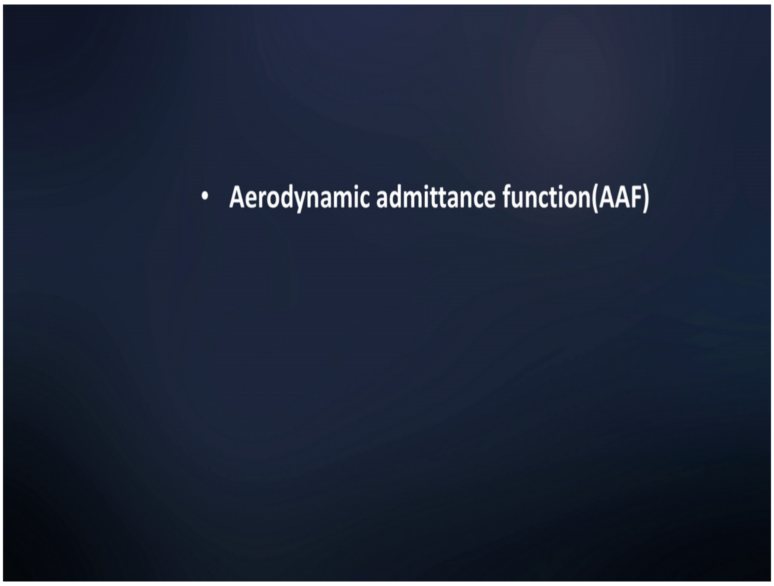

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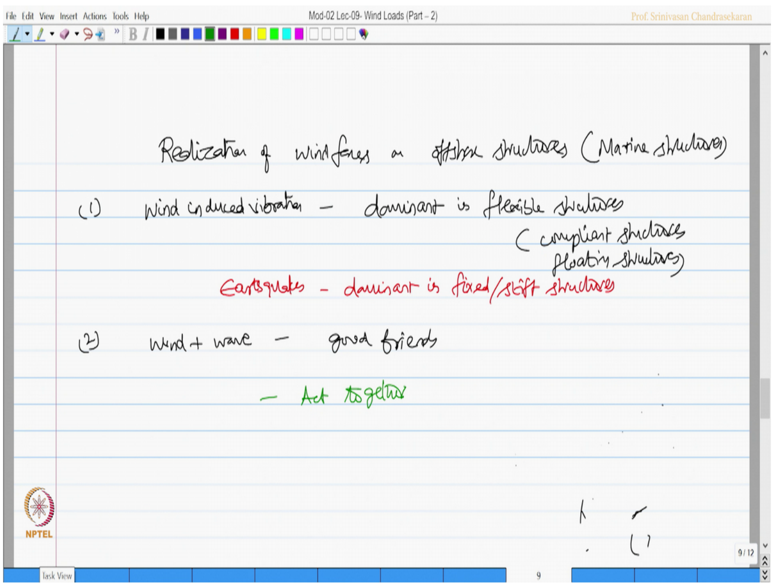

Now, as applicable to marine structures or offshore structures, let us talk about one important point called Realization of wind forces on offshore structures. I mean to some extent we can say this as marine structures also is applicable to coastal structures as well, you can even say this. We have learnt about earthquake as important source in terms of environmental loads, you know wind induced vibrations are actually dominant in flexible structures.

As far as offshore structures are concerned, they are very important in compliant structures, floating structures etcetera just for comparison earthquakes, just for comparison earthquakes are dominant in fixed structures or stiff structures. Most bothering feature is that wind and wave are actually good friends, why because they generally act together.

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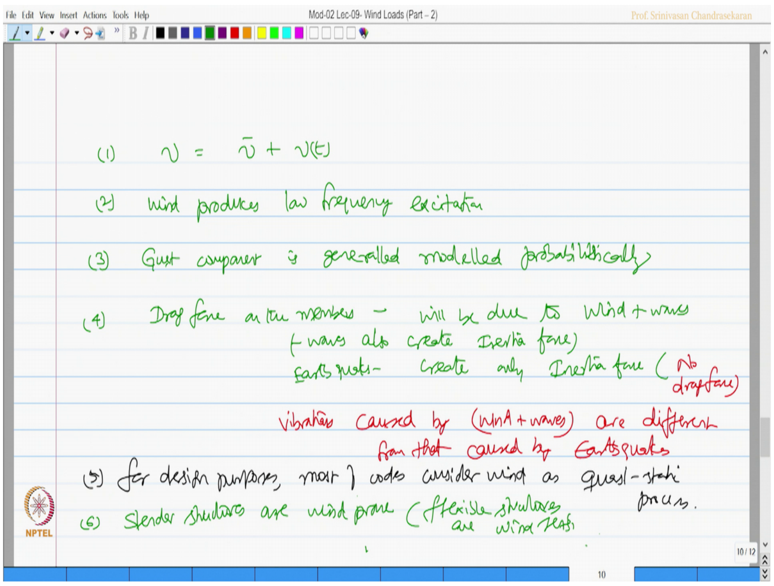

So, let us understand few terminologies we know v is now going to be v star plus v of t, the second issue is it is got 2 components the main component and the gust component. We also understand that wind produces low frequency excitation, the third component which is very important the third point is the gust component is generally modeled probabilistically. The forth point which is important is drag force on the members will be due to wind and wave, waves also create inertia of earth quakes create only inertia force no drag force.

Therefore vibrations caused by wind and waves are different from that caused by earthquakes. The good news is that for design purposes, most of the codes consider wind as quasi static process, but we should remember an important point slender structures are wind prone. So, flexible structures you can say are wind sensitive.

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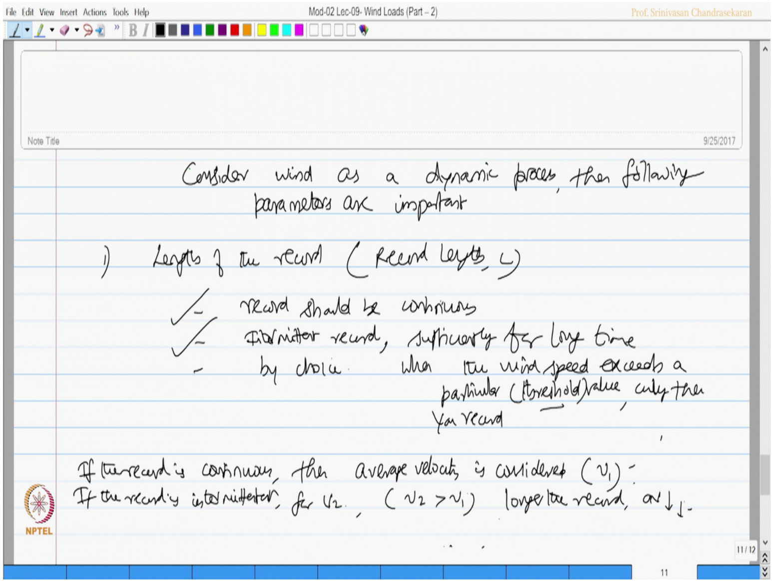

Suppose if we want to consider wind as dynamic process not as a quasi static process, consider wind as a dynamic process then following parameters are important. One length of the record we can also call this as record length. So, record should be continuous that is one option, can also make intermittent record got sufficiently for long time. Sometimes they are also measured depending upon the choice that is when the wind speed exceeds a particular let us say threshold value, only then you record.

So, recording has got different options it can be continuous it can be intermittent and constant interval, let say every ten seconds every one minute you can record you can also do it by choice right you keep on measuring when the wind speed exceeds its threshold value you record otherwise you do not. If you have a record continuous if the record is continuous, then you take an average is considered for the design.

Let us say that average is v 1, if the record is intermittent let say the velocity is for v 2 it is seen that v 2 is generally greater than v 1 because longer the record average will be lower ok.

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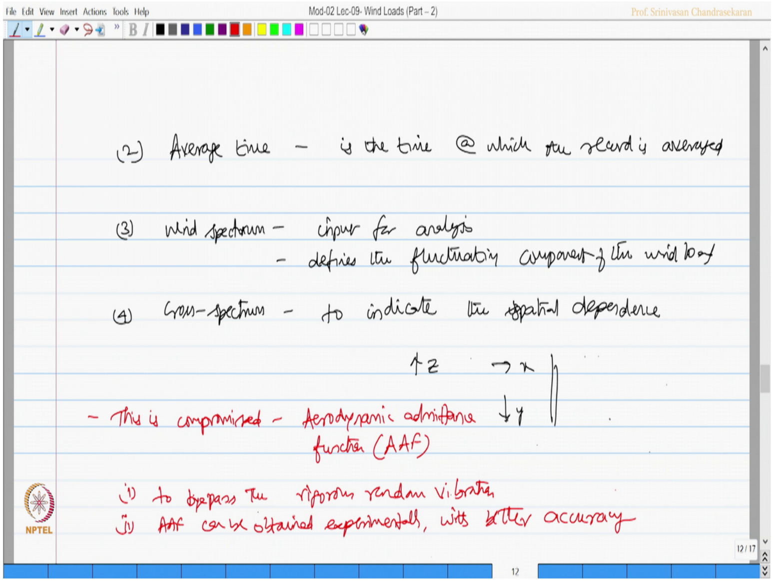

Second is the average time; average time is the time at which the record is averaged the third factor is a input. So, wind spectrum is an important input for analysis, actually this defines the fluctuating component of the wind load.

The forth one could be something called cross spectrum. Cross spectrum is actually to indicate the spatial dependence of wind velocity along height, along x and along y. It becomes a three dimensional variation will difficult to handle. So, this is compromised in analysis by using aerodynamic admittance function. There are 2 reasons why aerodynamic admittance function is being used; one reason is it is to bypass the rigorous random vibration theory, second AAF can be obtained experimentally with better accuracy.

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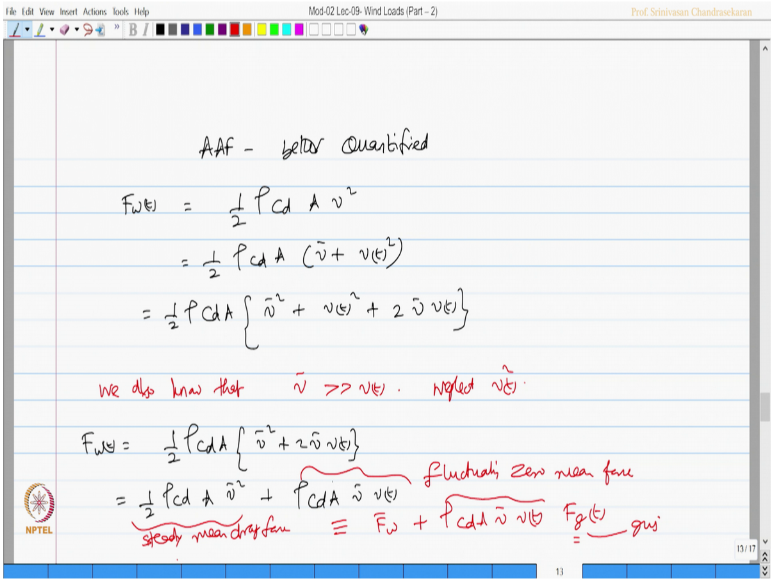

So, it can be easily quantified. So, aerodynamic admittance function is better quantified. So, we know that the total load because of wind is going to be half rho CdA v square, which can be half rho CdA v bar plus v of t square, which can be expanded as half rho CdA v bar square plus v of t square plus 2 v bar v of t.

We also know that from the literature that v bar is much greater than v of t, we can also neglect v t square. So, doing that we can now say Fw of t is half rho CdA v bar square, plus 2 v bar v of t, which can be a said as half rho CdA v bar square plus rho CdA v bar v of t. So, we call this component as steady mean drag force, we call this component as fluctuating zero mean force. Now this can be expressed as steady drag component mean component plus rho CdA v bar v of t, we call this as F g of t. So, g stands for gust.

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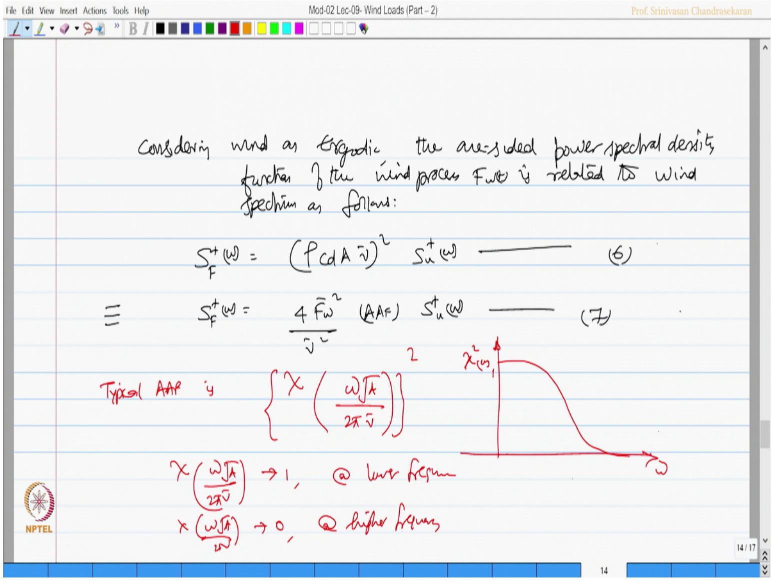

Considering wind as an ergodic process the one sided power spectral density function of wind process F w of t is related to wind spectrum as follows is given by rho CdA v bar square S u omega, we calls equation number 6. We can now say I replace the gust component with aerodynamic admittance function, I can say this spectrum is now given by 4 F bar square by v bar square of aerodynamic admittance function of Su omega call equation number 7.

Now, typical aerodynamic admittance function is a chi function of omega root of A by 2 pi v bar square. So, the typical plot of this looks like this, for increase in omega the chi function of omega will vary. So, this becomes 1 and this is 0 so on the other hand, when omega root A by 2 pi v bar tends to 1 at lower frequency chi function of tends to 0 at higher frequency.

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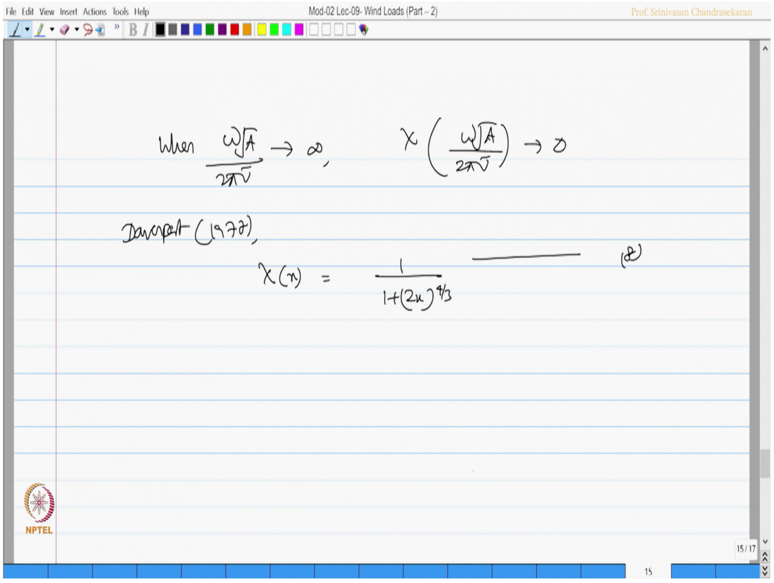

That is when omega root A by 2 pi v bar tends to infinity, the chi function of omega root A by 2 pi v bar tends to 0. In general as given by Davenport in 1977 chi of x is equal to 1 by 1 plus 2 x to the power 4 by 3.

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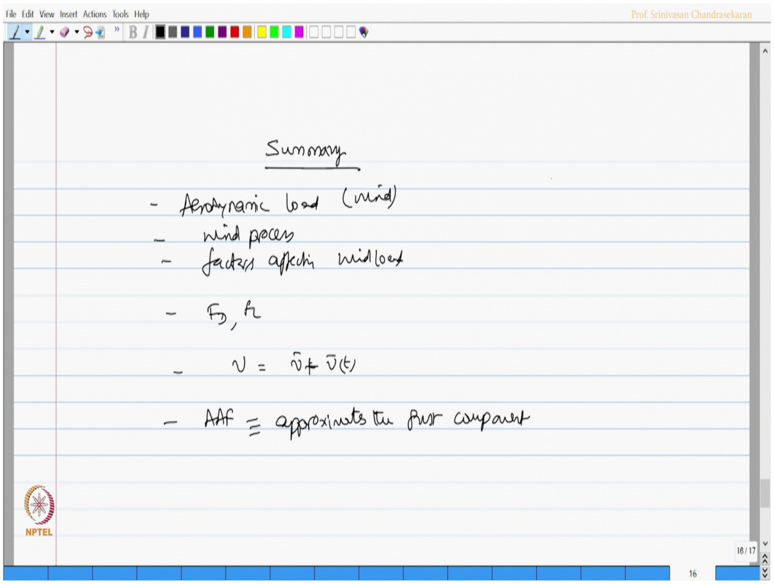

So, friends in this lecture we started understanding aerodynamic load that is wind load caused by wind. We learnt something about the wind process, factors affecting wind load the drag force and the lift force, then wind velocity as got 2 components the main and the gust component, then aerodynamic admittance function, which approximates the gust component which we plot and understood.

So, in the next lecture we will talk about the wind spectrum and try to learn how the wind spectrum equations can be plotted using a numerical code or a MATLAB code, we will do couple of problems to understand how they can be computed by simple hand computations and one can also write the simple program to do this which I will show you in next lecture.

Thank you very much.