Computer Methods of Analysis of Offshore Structures
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Module - 02
Lecture - 10
Wind Loads - 2 (Part - 2)

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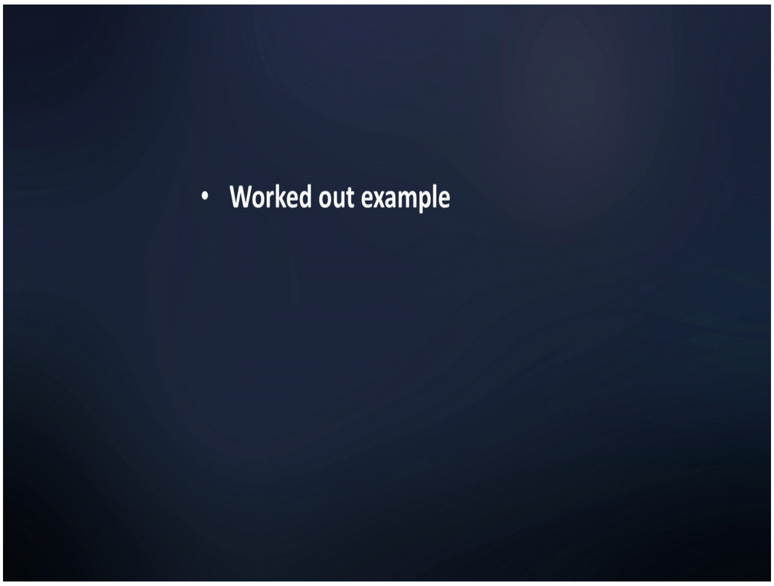

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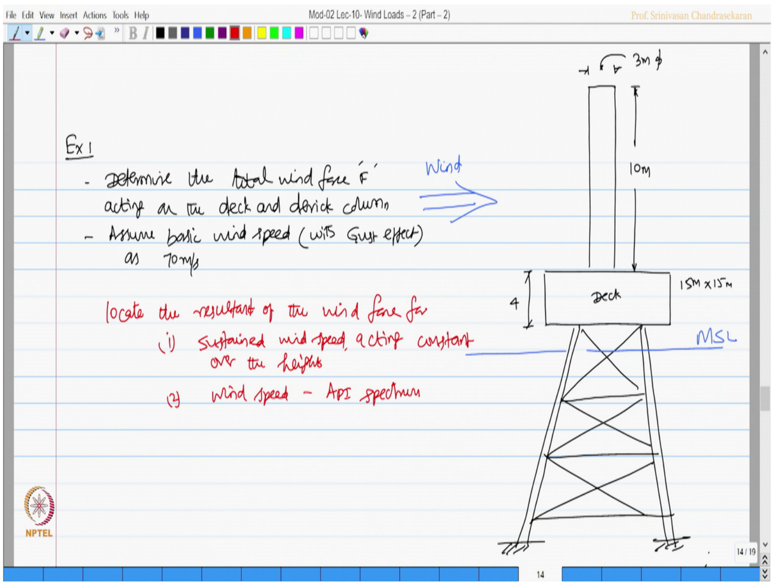

Let us say I have a body, which is a lantern which is fixed on a deck. The deck is supported by a jacket and the jacket is resting in the seabed by some pile foundation of course, the jacket has got bracings and battens. Let us may this is my mean sea level this may a wind direction and this height is 10 meters and the diameter is 3 meters and this is the deck, the deck is 15 meter by 15 meter and the height of the deck is 4 meters. So, what is asked in this question or the example is determine the total wind force F acting on the deck and a derrick column assume basic wind speed with gust.

So, gust factors multiply as 70 meter per second; what is asked is locate the resultant of the wind force for two cases for one. Sustained wind speed acting constant over the entire height 2 wind speed follows API spectrum.

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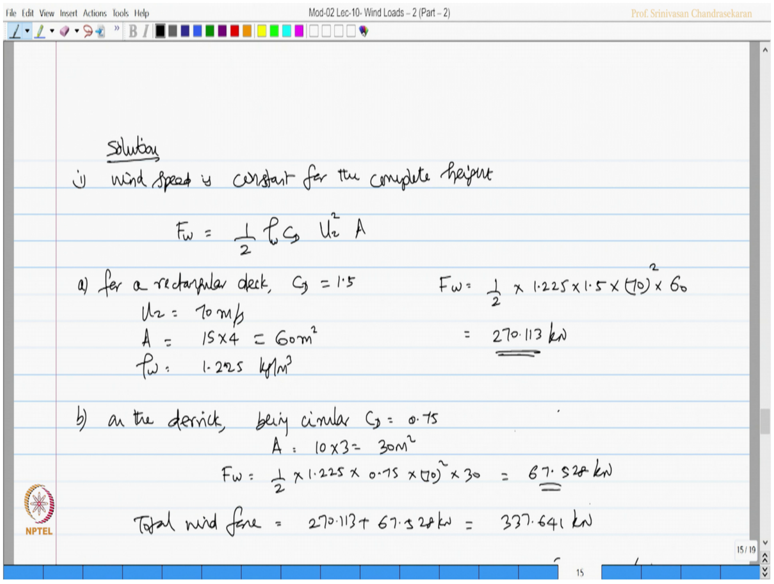

So, let us say solution, for the first case wind speed is constant for the complete height we know that force because of wind is given by half rho CD rho of wind CD U z square and the projected area.

Let us say for a rectangular dick the drag coefficient is 1.5 and we already said take u c U z as 70 meter per second and area projected if you look at this figure deck is 15 meter by 4 meter. So, I should say the projected area will be 15 meter. So, this are projected area. So, it us going to be 15 meter by 4 which is 60 square meter and we know density of wind we already said that 1.225 kg cubic meter. So, that gives me F w as half 1.225 1.5 70 square into 60, which is so much kilo Newton this is on the deck.

Now, on the derrick being circular CD is 0.75 and area you look at this figure diameter is 3 meter height is 30 meter sorry 10 meter. So, area is going to be 10 into 3 30 square meters. So, F w is going to be half 1.225 into 0.75 into 70 square into 30, which gives me 67.528 kilo Newton. The total wind force is summation of these two which is going to be 337.641 kilo Newton.

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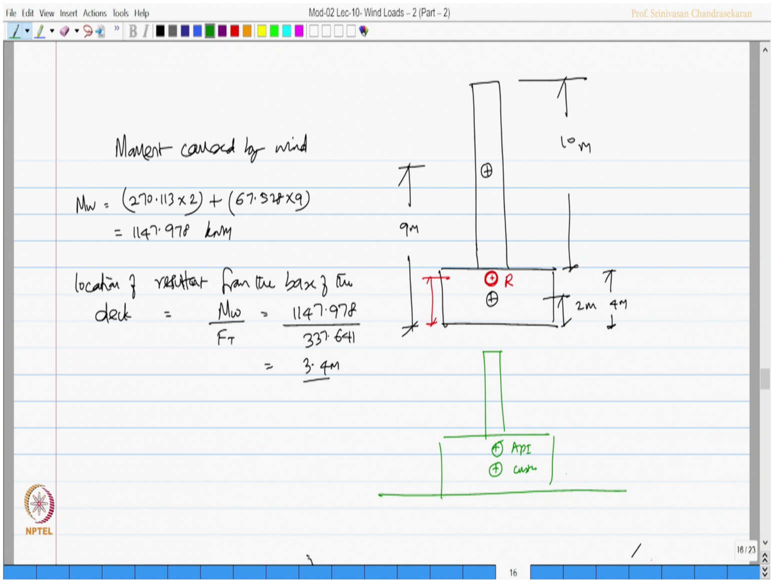

So, let us say we want to find the moment, moment caused by wind. So, we already have two objects one is the derrick other is the deck, Cg of the deck is somewhere here cg of the derrick is somewhere here, we know this is going to be 2 meters because this is 4 meters and we know this is 10 meters. Therefore, this is going to be 5 plus 4 9 meters from this bottom. So, the moment due to wind is going to be 270.113 that is on the deck into 2 meter plus you can see here 67.528 into 9 meters, which is 1147.978 kilo Newton meter.

I want to find the location of resultant from the base of the deck I can say that is equal to moment by the total force, which is 1147.978 by total force is 337.641 which gives me 3.4 meters which is somewhere here this is the point, where the resultant of the force is acting let us solve this problem using API code as well.

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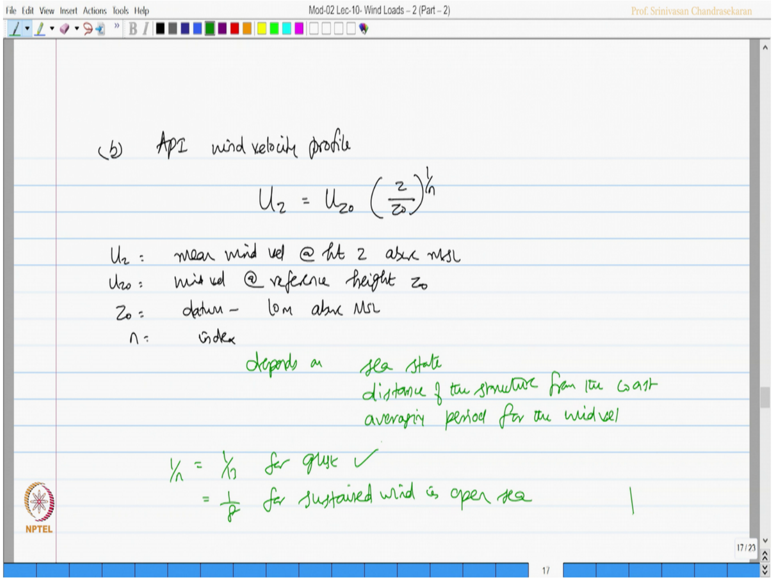

So, b using API wind velocity profile; we already given the governing equation for the spectrum AP wind velocity says U at any z will be given by U z 0 z by z 0, 1 by n where U z is the mean wind velocity at height z above the mean sea level U z 0 is wind velocity at reference height z 0. Z 0 is the datum which is generally 10 meters above the mean sea level and n actually is an index this index depends on sea state distance of the structure from the coast and averaging period for the wind.

Usually, 1 by n is 1 by 13 for gust wind; it is 1 by 8 for sustained wind in open sea. In the specific problem we have been asked to include the gust effect. Therefore, we will take this value as 1 by 13.

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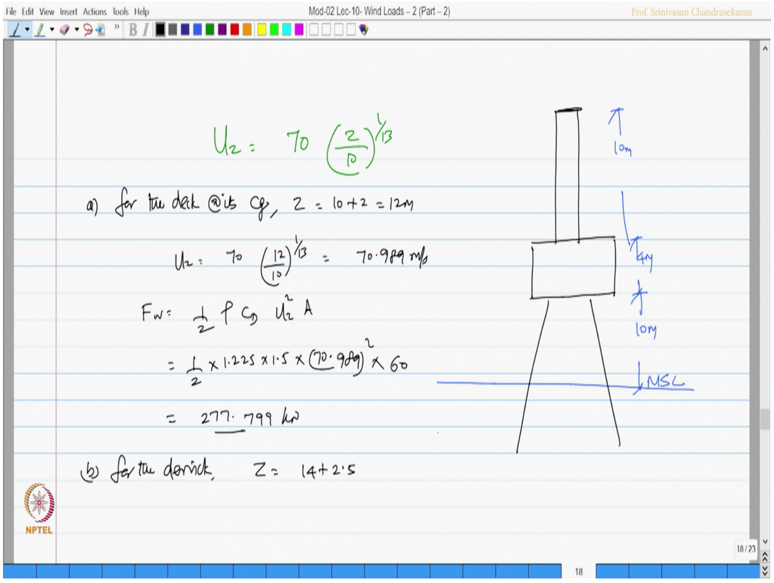

So, in that case Uz will be given by 70 z by 10 of 1 by 13 where 70 is the mean velocity in meter per second, now I want to calculate this for the deck for the deck at its Cg. Let us say this is my derrick this is my deck which is supported by a system and this is my mean sea level.

Let us say this, the datum we say it is 10 meter and we already know this is 4 meters and this is again 10 meters. In that case for the deck that its Cg z value will be 10 plus 2 which is 12 meter therefore, U z is going to be 70 into 12 by 10 raised to the power 1 by 30, which gives me 70.989 meter per second. So, wind force is half rho CD U z square projected area, which is half into 1.225 into 1.5 into 70.989 square and the projected area remains same as we worked in the last case which is going to be 277.799 kilo Newton.

Now, b for the derrick z is going to be 14 plus 2.5 because you want to divide this into 2.

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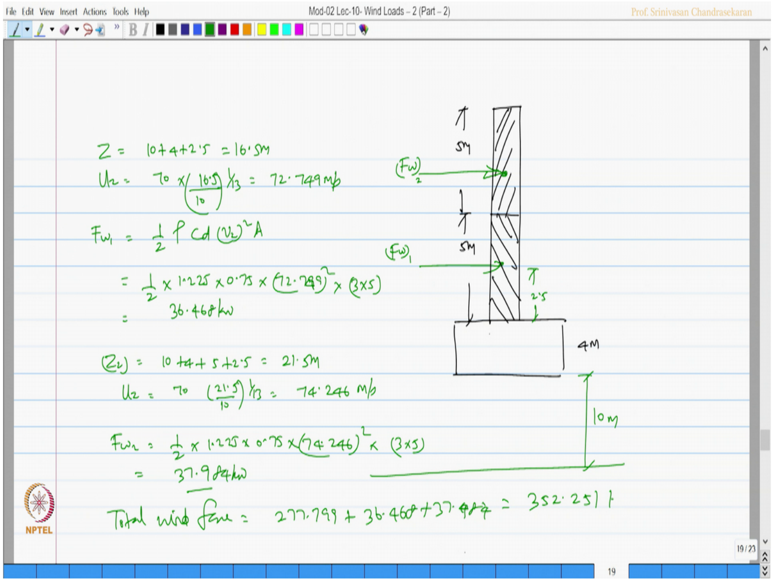

So, I take this as derrick as two objects, this is one this is the other this is my deck which is 4 meters and I divided this as 5 meter and 5 meter. I call this as Fw 2 and this as Fw 1 and this is going to be 2.5 and this may MSL which is 10 meter therefore, z is going to be 10 plus 4 plus 2.5 which is 16.5 meter. So, Uz is going to be 70 into 16.5 by 10 to the power 1 by 13, which is get 72.749 meter per second therefore, Fw 1 will be half rho CD vz square projected area, which is half 1.225 into 0.75 that is cylindrical 72.749 square multiplied by projected area is going to be 3 into 5; 3 is the diameter and 5 is the height which gives me 36.468 kilo Newton.

Similarly, for the second piece z 2 is going to be 10 plus 4 plus 5 plus 2.5 which is 21.5 meters. So, again Uz 70 21.5 by 10, 1 by 13, 74.246 meter per second and Fw 2 is half into 1.225 into 0.75 into 74.246 square into 3 into 5 which gives me 37.984 kilo Newton.

Now, the total wind force is 277.799 that is the deck wall plus 36.468 plus 37.984 which gives me 352.251 kilo Newton.

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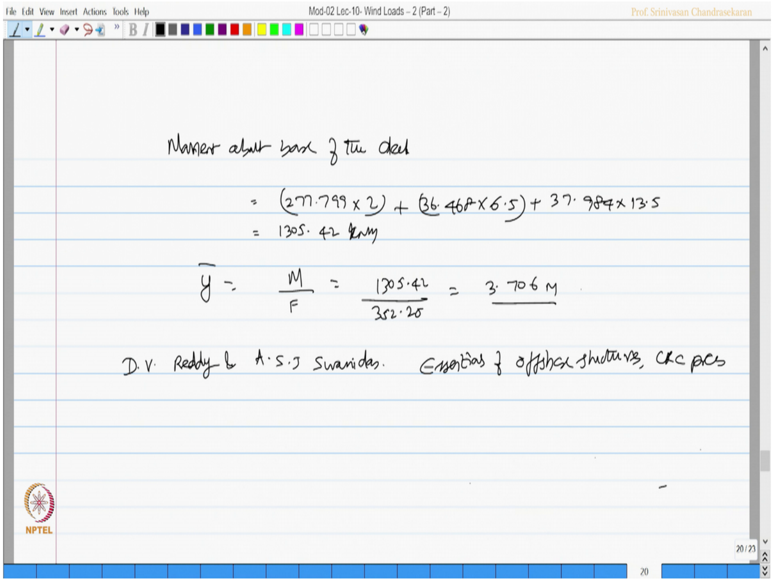

I want to now workout the moment, moment about base of the deck is going to be 277.799 into 2 that is a deck wall plus 36.468 into 6.5 plus 37.984 into 13.4 which gives me 1305.42 kilo Newton meter therefore, y bar cg is going to be M by F which is 1305.42 by 352.25 which is 3.706 meters.

This has a reference we can refer also to D.V Reddy and A.S.J Swamidas essentials of offshore structures CRC pres. So, friends the resultant of this is 3.706 whereas, in the earlier case this was 3.4. So, one can try to plot this in this figure. So, in the first case it was from the deck we plotted this already here and 3.706 I should plot this slightly let us say this is my derrick this is my deck one Cg another Cg, this is because of API this is because of constant that is what can compute. So, the problem clearly explains how to use API code as well as constant value for estimating the moments and the certain due to wind.

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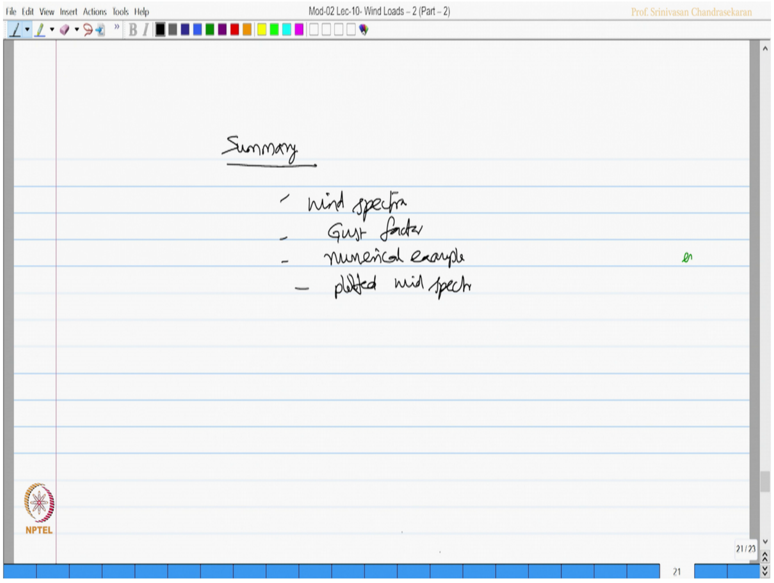

So, friends in this lecture we learnt equation for different wind spectra. We also learned the average gust factor which can be used to convert the, include the gust factor in the velocity component. We also did a numerical example we also plotted different wind spectra and understood the difference and variation with respect to the force.

Thank you.