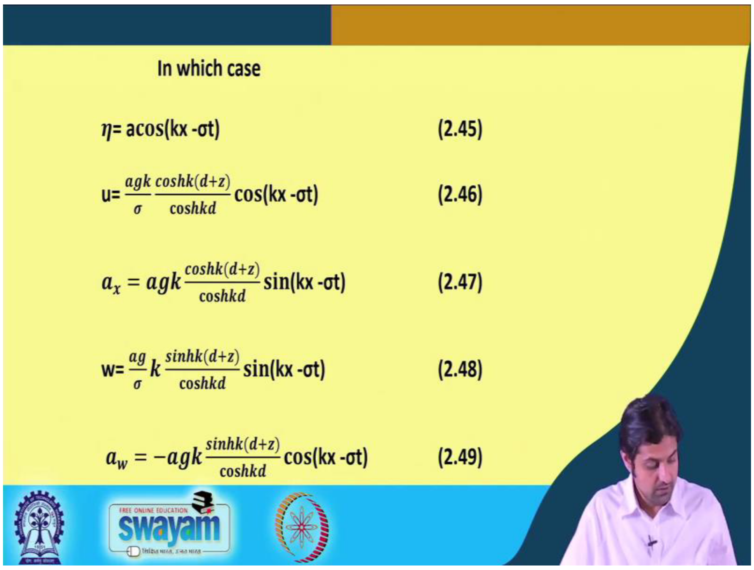

So, in this case eta will be a cos k x - sigma t, the u will change u and a x and w and a w, so, if we assume a different velocity potential you remember we had to velocity potentials. So, we started doing all the calculation with the first velocity potential but instead of the first day we started with the second we will obtain this set of the wave kinematic parameters.

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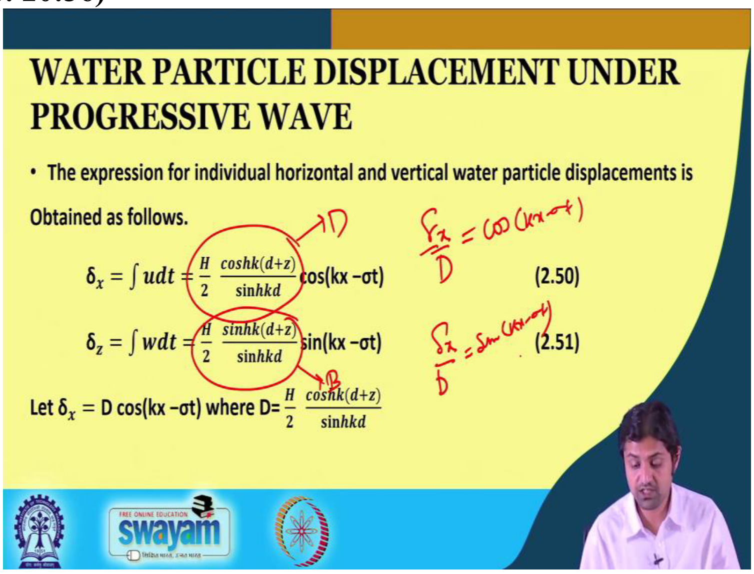

So we have studied the velocity potential, we found out the velocities under the progressive where we have found out the acceleration now importantly we have to find out water particle displacement is nothing but integral u times g T w times d T in extend that direction respectively. So, the expression of individual horizontal and vertical particle displacement is integral u dt u we already know in terms of h before.

So, the final results comes out to be h by 2 cos hkd + z phi by sin hkd into cos k x - sigma t. Similarly, the vertical displacement delta z is given by h by 2 sin hkd + z into sin hkd into sin k x - sigma t these are the periodic terms. So, once you derive the velocity potential everything can be found out. Now, if we say delta x = d cos k x sigma t k x - sigma t and we said D is h by 2 cos h k d + 0 divided by sin hkd and similarly.

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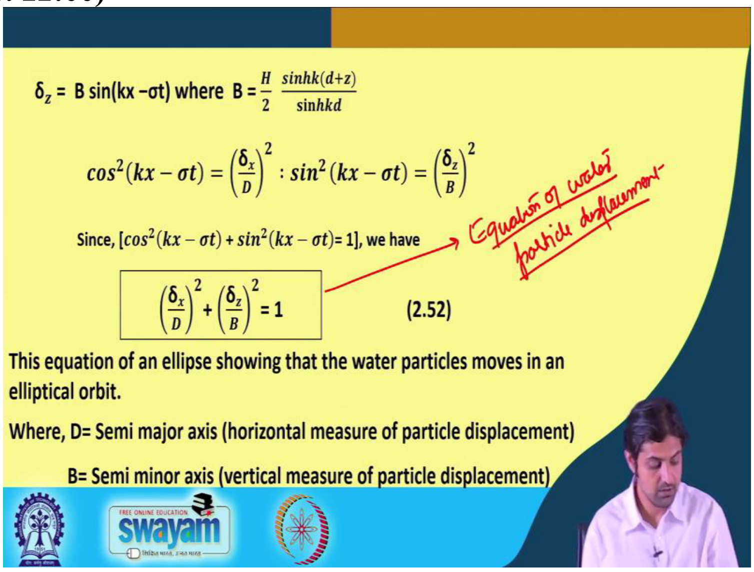

We assume delta z is B sine k x - sigma t where B is a different quantity called h by 2 sin hkd + z divided by sin h therefore, we can right cos squared k x - sigma t is delta x by d whole squared, let us go back. So, what we have said is this is D and this is B. So, if we take D down so, it will become delta x by d = cos k x - sigma t and if we take D down here it becomes delta z by D = sin k x - sigma t. So, sin squared theta + cos squared theta = 1 therefore, this is what we have used.

So, what we write is delta x by D whole squared + delta z by B whole squared = 1, this is in general what type of equation if D is not equal to be elliptical. So, this is an equation of analysts showing that water particle moves in in an elliptical orbit. So, we have proved particle moved in an elliptical orbit. Here D is the semi major axis at the horizontal measure of the particle displacement and B is these semi minor axis that is the vertical measure of the particle displacement. So the vertical the particle displacement this is an important equation.

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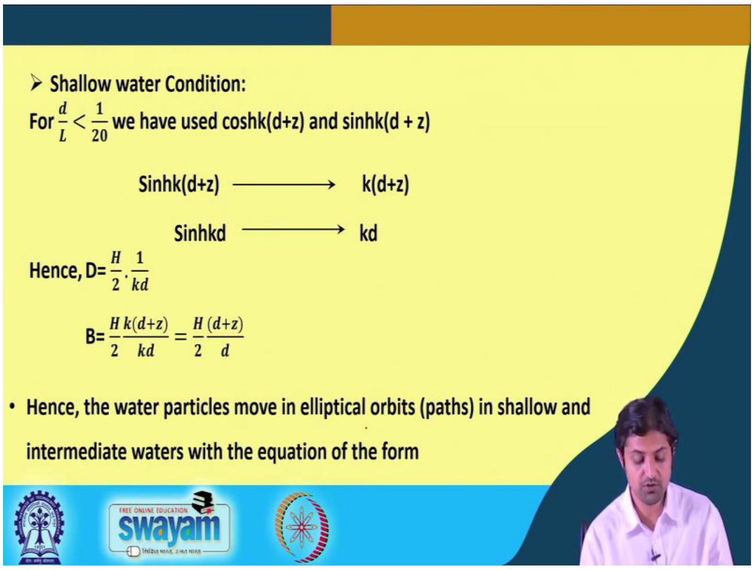

Now we analyze this displacement in shallow water. So what happens in shallow water for d by L less than 1 by 20 we have 0.05 we have used cos hkd + z and sin hkd + 2 sin hkd + z goes to k d + z and sin hkd goes to kd.. Hence, D will be what if we as you remember D was this equation D was h by 2 cos hkd + z and sin hkd in shallow water this becomes kd + z divided by kd. So this capital D becomes h by 2 into 1 by kd and B becomes h by 2 k d + z by kd hence the water particle in shallow water moved in analytical orbit in shallow and intermediate waters with the equation of the form.

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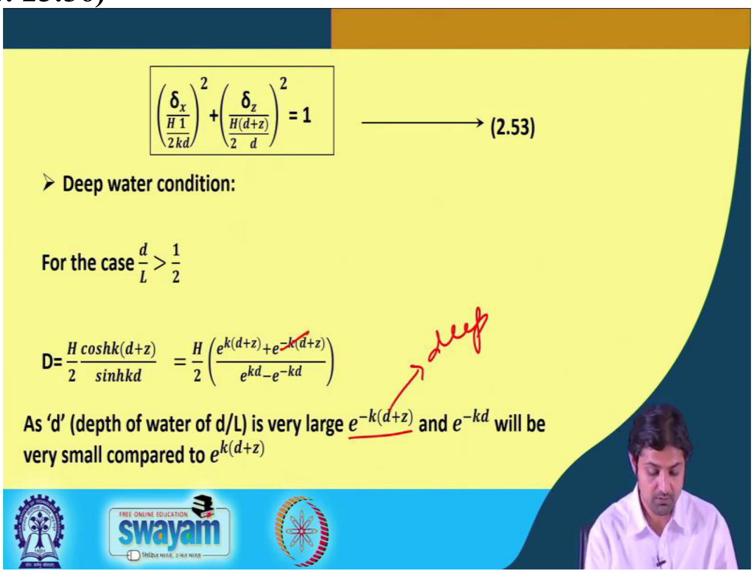

If discuss just simply substituted in shallow and intermediate shallow and intermediate waters with this D and B but in deep water for the case d by L greater than half D becomes h by 2 e to the power k d + z + e to the power - kd + z divided by e to the power kd. - e to the power - kd as D is very large e to the power - k d + z and e to the power - kd will be very small correct because this deep now, so, if it - sin they will be very small compared to e to the power k d + z. So, this can be taken away.

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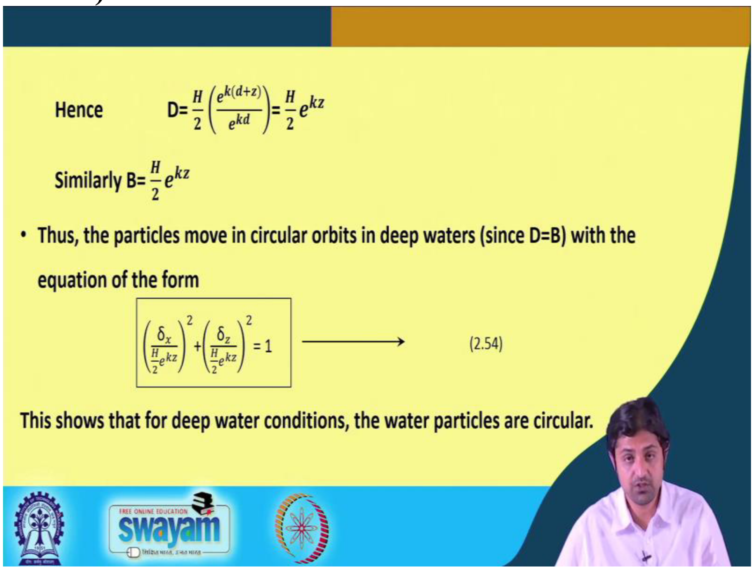

And therefore, we can right h by 2 e to the power kd + z divided by e to the power kd and simply h by 2 e to the power kz. This is important. Similarly, if we do the same process with B, we will again get h by 2 e to the power kz because deep water that is going to happen again. Therefore, you see, both B and D are same. So, in an ellipse if both the major and minor x is the same, it is nothing but a circle.

Therefore, the particles move in circular orbits in deep water since these equal to be with the equation of the form delta x divided by h by 2 e to the power kz + delta z h by 2 e to the power kz whole squared = 1. So, see these things are very important these are the type of questions which you can expect what type of orbit in deep water then you have to take mark the correct 1 as a circular orbit elliptical orbit. This shows that for deep water condition the water particle trajectories are circular.

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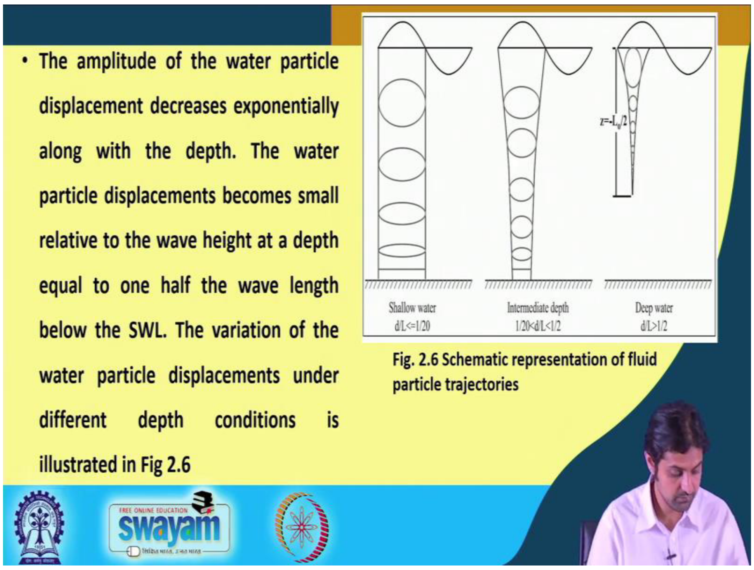

So, you see, this is the representation the schematic representation of fluid particle trajectories the amplitude of the water particle displacement it first of all it decreases exponentially along the water depth the water particle displacement becomes small relative to the wave height at a depth equal to one half the wavelength below this still water level that is the deep water the variation of the water particle that displacement under the depth condition is illustrated in this.

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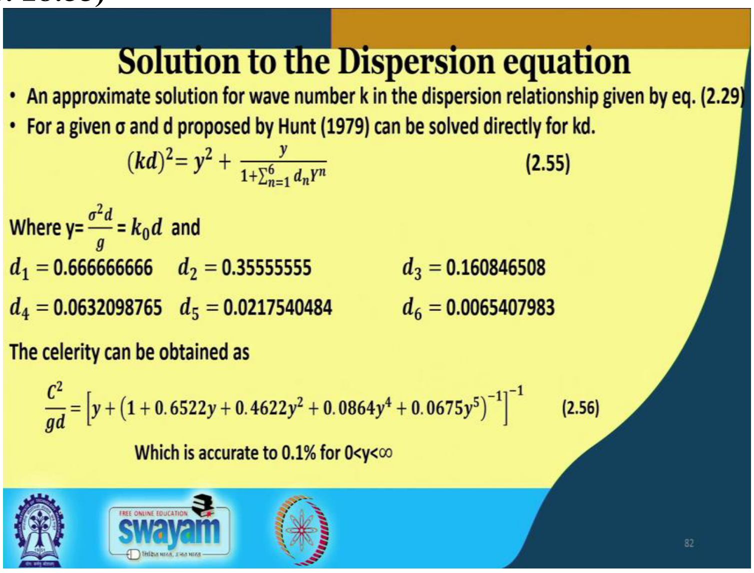

So, there is 1 last thing before the end of this lecture, I have included in the slide but does not have any significance for this particular course. You see the dispersion relationship, I said there are 2 solutions. One is either using the wave tables and the second is trial and error. But some scientists like hunt he came up with the direct solution for kd. He said kd squared = y squared + y divided by 1 + n goes from 1 to 6 dn Yn.

And this final equation can be used in mat lab or Excel to determine for different wise so if you can put it on a computer code using mat lab or Excel, you the you There is no need for you know, iteration or any other method. So this is just for information purpose. You do not need do not need to remember maybe the name you know the if somebody is interested in doing further research or going for a master is program or you know, something related to research they can use this equation as such. So, with this actually this equation is accurate for 0.1% for y going from 0 to infinity.

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So, I think this is a fine point to stop. In the next lecture, we will conclude this module of invested flow that is wave mechanics and we start with the pressure distribution and the progressive waves from the next lecture and finish this module. And this will also be the end of the course, but I will talk about it in the last lecture of this course called hydraulic engineering. Thank you so much for listening. See you in the next lecture.