Foundation Design
Prof. Nihar Ranjan Patra
Department of Civil Engineering
Indian Institute of Technology, Kanpur

Lecture – 10B
Stress Distribution in Soils-Part 3

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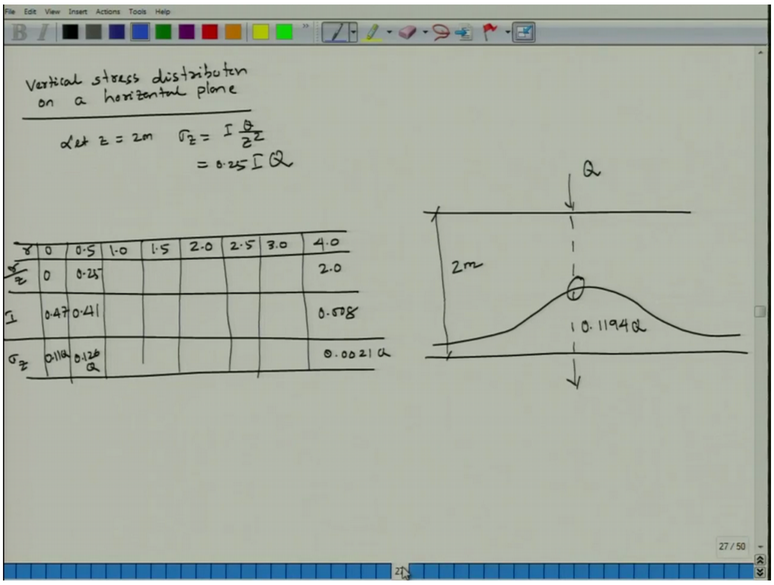

So last class I have covered vertical stress distribution on a horizontal plane. And as well as vertical stress distribution on a vertical plane.

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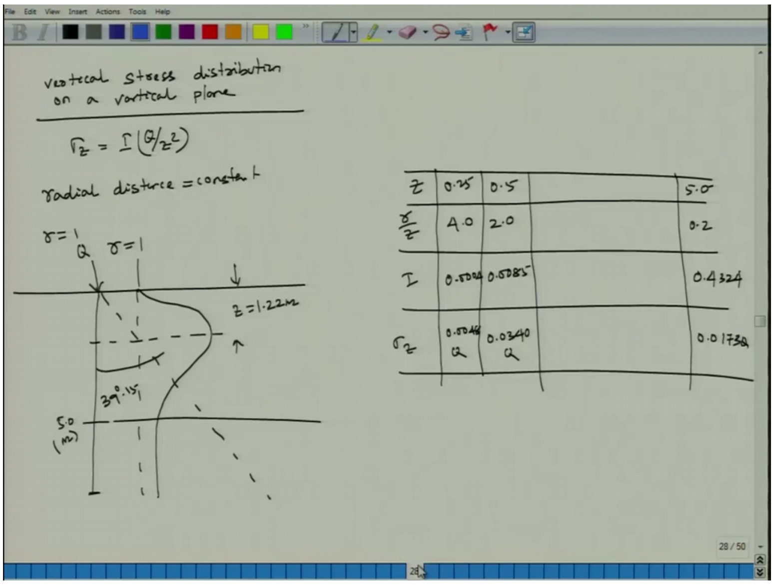

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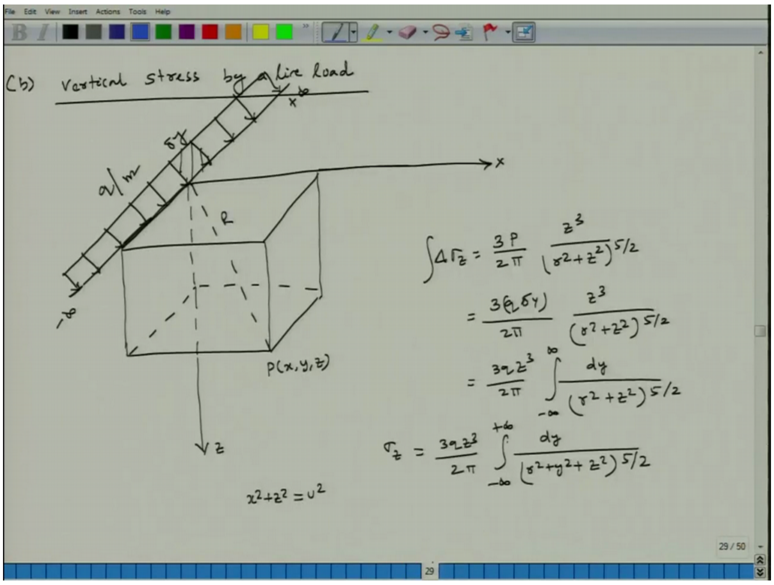

Then considering point load, it has been extended to find it out vertical stress by a line load. Then vertical stress distribution by a strip load again considering point load.

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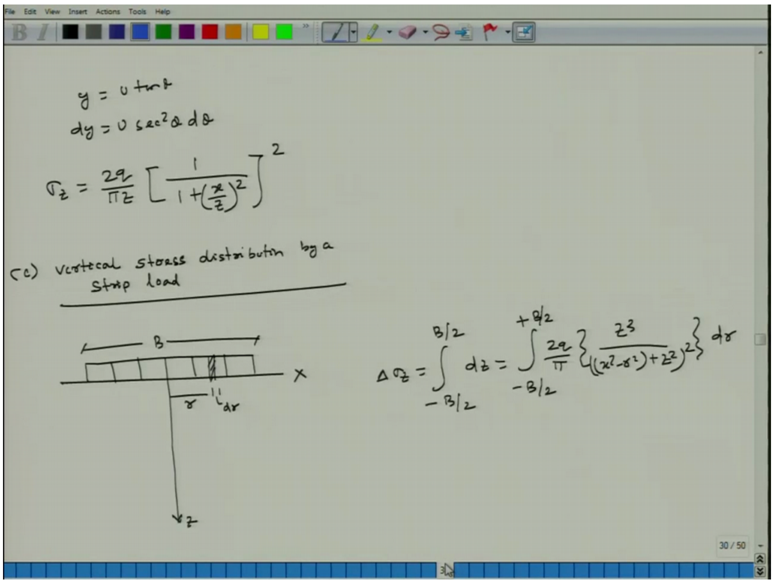

Then it has been extended taking into a small par pursuance, then it has been integrated over that strip zone minus B by 2 plus B by 2.

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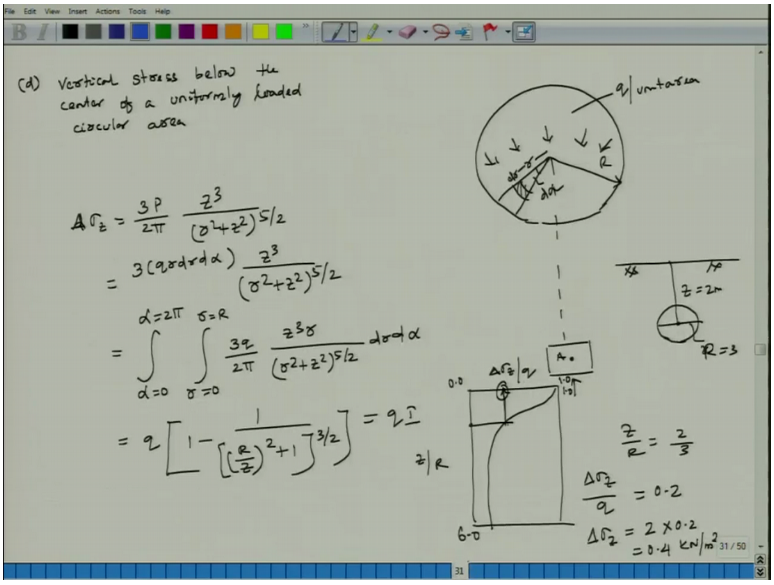

Then is your vertical stress below this center of a uniformly loaded circular area. Again this has been taken into a small strip or small dr and it has been integrated considering as a point load. Then we got a chart, this chart is your delta sigma z by q divide by z by f R, once you know the radius of your circular area and distance below the ground surface where increase in stress has to be calculated then you can calculate what is the increase in stress because of your circular loaded area.

Then come to point that is your vertical stress below this center of a uniformly loaded circular area, then come to your vertical stress by a rectangular loaded area.

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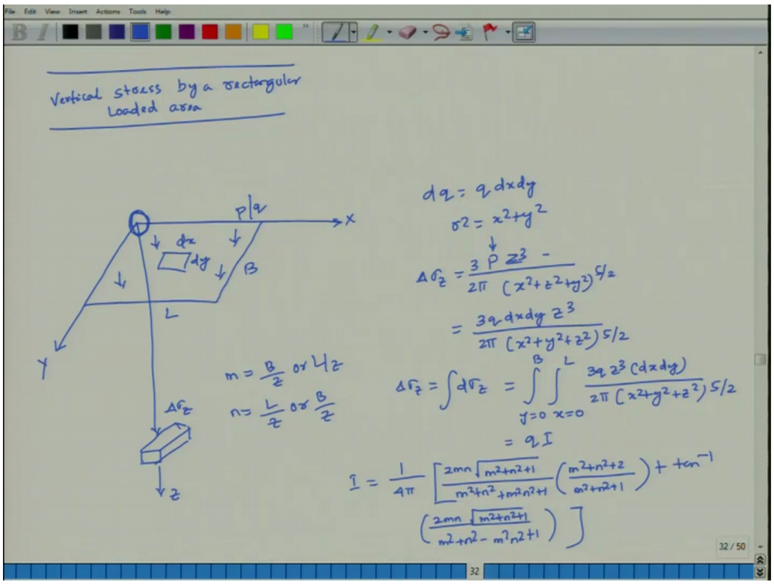

Vertical stress by a rectangular loaded area. So, look at the figure here. This is your delta sigma z and it is coming your direction z. This is your x say this is your y and this direction is your z. I am taking it. So, this will be dx and dy. And this is your L and this is your B. This load has been distributed over uniformly over the rectangular area. So, I have consider a small area of size dx and dy. The area is having length L width p. Then if I write it dq is equal to q into dx dy. R square is equal to x square plus y square. Then delta sigma z which is equal to p z cube considering as a as if it is a (Refer Time: 04:09) point load, 3 by 2 pi x square plus z square plus y square to the power 5 by 2. And this will be your z q. Then if I consider that particularly your p, or may be q loading in density q, then it will be p will be taken as small p or it is a q, small p or it is a q. Then I can write it 3 small q dx dy z q. This p or q over the area loading density capital P is your point load small q is your loading intensity I can remove that small q.

Now, if I converted into p into p is equal to q into dx dy, then it will be 2 pi and it will be x square plus y square plus z square to the power 5 by 2. So, delta sigma z if I integrate over your d sigma z. So, it will be double integration because dx has to be integrated over the 0 to L. And dy has to be integrated over y is equal to 0 to b. So, it will be y is equal to 0 to B, then x is equal to 0 to L, then it will be 3 q z cube dx dy divided by 2 pi into x square plus y square plus z square to the power 5 by 2, which is equal to q into I.

So, delta sigma z if I am taking out the q, I is your influence factor. Then if I put it, if I put it I which is equal to it comes out to be one by 4 pi into 2 mn root over of m square plus n square plus 1 divided by m square plus n square, plus m square n square plus 1 into m square plus n square plus 2 divided by m square plus n square plus 1 plus tan inverse I take the bracket 2 mn by root over of m square plus n square plus 1 divided by m square plus n square minus m square n square plus 1. This is the value of this, this m and n m is equal to either B by z or L by z, which where you are taking whether you put it L here B or B here L does not matter n is equal to either L by z or B by z. Entire chart is given.

So vertical stress in a rectangular loaded area if there is a rectangular loaded area, what is the increase in vertical stress at this point at the corner below this you can. So, for impose you can find it out also at the center, and this charts are allowed for examinations. Now come to the next that is your increase in stress or approximate stress distribution method.

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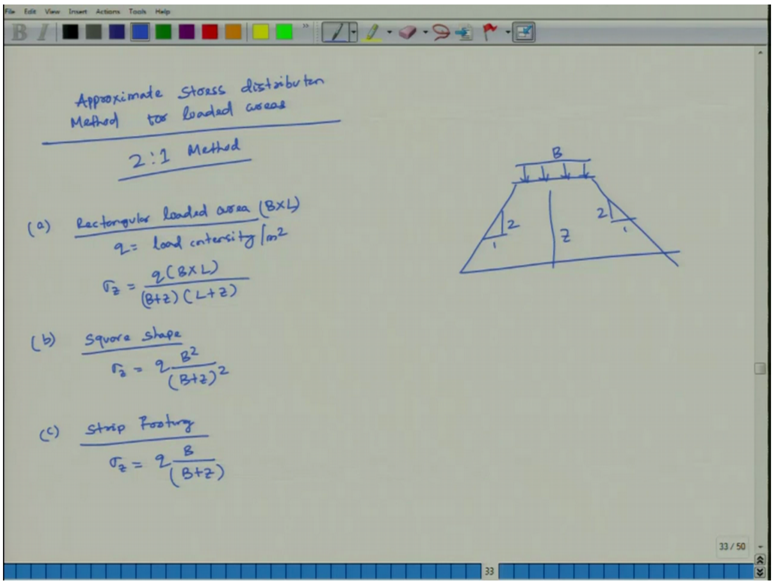

Approximate stress distribution method for loaded areas. These are all point load then there is a strip load, line load, then there is circular load at the center then rectangular load at the corner. Then if you want to find it out suppose there is no chart if we want to find it out approximate distributions approximately what should be the value it is called 2 is to 1 method. It is called 2 is to 1 method.

So, if I put it in this way, this is B. This is 1 and 2, this is one and 2, then for rectangular loaded area a because it will be distributed with your 2 is to 1; that means, the variation will be 2 vertical to one horizontal. So, for rectangular loaded area; that means, B by L and q is equal to load intensity divided by meter square. Then sigma z is equal to q B by L divided by B plus z into L plus z.

Now similarly for square shape, square shape sigma z is equal to q into B square by B plus z whole square. Similarly, for strip footing, strip footing sigma z is equal to q into B by B plus z. Sigma z is equal to q by B plus z into B. This is what by means of approximate method you can do it because this is a 2 is to one distributions. So, if this distance is your B by means of 2 vertical and one horizontal and if this is your height is z you can very easily find it out what is the width of this here. Then from their based on that you can find it out for 2 is to one method, sigma z what is there for square shape what will be there and strip footing what will be there. Now based on your approximate method, there are 2 cases, one is your equivalent point load method other is your, you can say that it is equivalent point load method. So, what is equivalent point load method.

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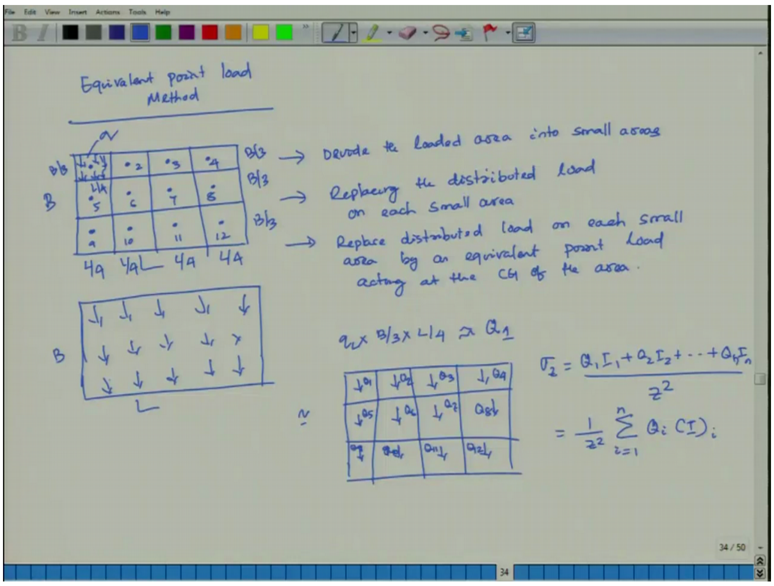

For example, this is the loaded area. This is my loaded area in this loaded area. So, you can name it 1 2 3 4 5 6 7 8 9 10 11 12.

So, divide the loaded area into small areas. Why it is called equivalent point load for example, this is a loaded area and here it is same loaded area rectangular shape, this will be B by L, this will be B by l. So, first principle is divide the loaded area into small areas. Divide the loaded area into small areas. And replacing the distributed load in each small area by an equivalent point load. Replacing the distributed load on each small area then replace distributed load on each small area by an equivalent point load, acting on the Cg of the area.

Suppose this is the area try to understand, these are all distributed load over the area. Now the entire area has to be, you divide the entire area into a small areas. I put it into a small area. And it should be equally do not put it unequal because it will be difficult. So, if you divide into 3 equal parts, suppose this will be B by 3, this will be B by 3, and this will be B by 3. Here it will be L by 4, here it will be L by 4, here it will be L by 4, here it will be L by 4 equally you distribute small area. Then entire suppose this distributed is 10 kilo newton per meter square, it acted over here B by L. Now this 10 kilo newton per meter square, this 10 kilo newton per meter square this distributed load, then you distributed over small areas.

So where this is our area B by 3 by L by 4, then that has to be distributed over this area. Then replace the distributed load suppose this is the distributed load over this area into equivalent point load. Equivalent point load means and that equivalent point load will act as on the Cg. In mechanics a point of view it is not going to be true. So, what will happen if it is equivalent point load and this is a distributed area. So; that means, suppose their distribution of area this is the udl is your q load intensity per unit area into ql into B by 3 into L by 4. Why? This is my B by 3, this is my L by 4.

So this is coming above to be point load Q1. Equivalent point load. So, this equivalent point load will act on Cg of this area. So, that is why it is called equivalent point load. So, what will happen if I convert into here make into here, in this way, how it looks like? It looks like this way. So; that means, there is a Q1, Q2, Q3, Q4, Q 5, Q 6, Q 7, Q 8, Q 9 Q 10, Q 11, Q 12, n number of then each point you calculate each point. Then this is a point load for taking into this is a point load, then your boussinesqs point load equation will come into picture boussines qs point load equation will come comes into picture. The what do it mean sigma z is equal to point load Q1 into influence factor I 1, plus Q2 into influence factor I 2 dot plus q n into I n divided by z square. Which is equal to 1 by z square summation of I is equal to 1 to n, and this will be your q I and I z or I.

So basically distributed load has been converted into equivalent point load. And once you get equivalent point load then from boussinesq equation by means of applied point load you are going to find it out increase in stress. And it is the summation of all the point loads over here depth. That is why this is called equivalent point load. Now we will analyze how equivalent point load will be effective for different cases.

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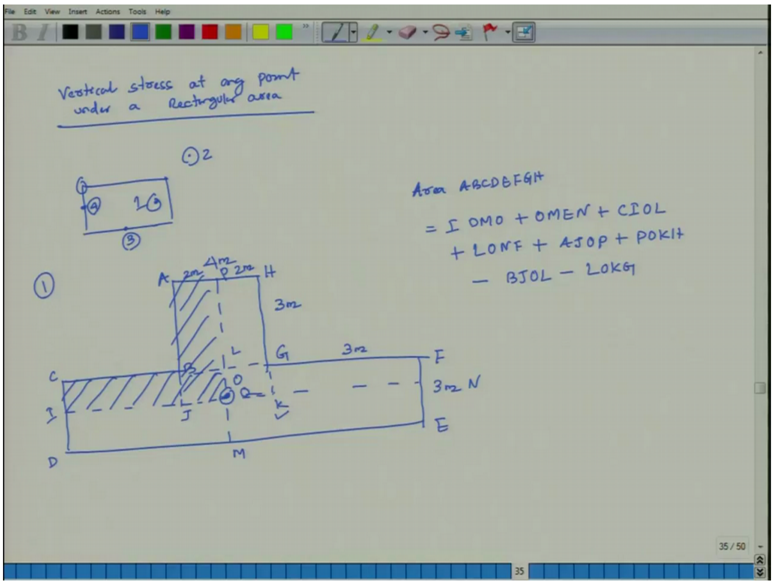

So, like vertical stress, at any point under a rectangular area. It is at any point any point, under a rectangular area means, if this is my rectangular area. Generally, what we have done earlier if this is the rectangular area generally by means of if you go back to here it is at the corner. So, it not necessarily always should be at the corner.

So you can find it out vertical stress may be here, 1 point, point 1. May be sometimes it is not at the Cg somewhere else outside the rectangular loaded area point 2. Then it may possible along the line point 3. Then it may possible along the line point 4. So, it is a vertical stress at any point under a rectangular area, rectangular loaded area at any point, right. Let us start with example there are many examples. So, I will continue and I will solve few problems. Let us start with an example just try to understand, this is the case sometimes foundation has been made in this way. So, all the dimension has been given, let me name it A, B, C, D, E, F, G, H. And this is your 3 meter. This is your 3 meter and this is your 4 meter. And this is also 3 meter all dimensions has been given. So, it has been asked find it out increase in stress at a point, this position look at here. This is your point O at a distance here one meter below civiler.

How we are going to do it? I have to make it into equivalent point loads; that means, what will happen? Let me put it in such a way that, sorry I say it is at a distance of 1.5 meter 1.5 meter, below this then this is the where point we are going to find it out. I put it this is 1.5 meter right. This your point O and this will be I take it at the center here this is lying also center here. So, this will be your 2 meter and this will be your 2 meter. And this junction I am taking it as a L. Now this is your m, and it has been extend. Suppose if I remove this 1.5 meter let me extend here, let me complete this one. So, this will be your B j and k. How do I get it? How do I get it? Try to understand before I write it this is my O, point O. If I consider this is your rectangular area, here you are getting at the corner, this is fine. This is one more rectangular area here you are getting at the corner.

This is one rectangular area where you are getting at the corner. Another rectangular area where you are getting at the corner. Then one more rectangular area where it is you are getting at the corner. And one more rectangular area where you are getting at the corner. Particularly for these rectangular area if we look at here. This is overlap. I am taking this rectangular area and if I take small rectangular area and if we are take these rectangular area completely, this is a common. So, it has to be deducted. Then I put it this is a rectangular area at the corner. My basic philosophy is, I bring back this rectangular loaded area, at the corner in such a way, that I am getting this point everywhere else at the corner of the rectangular loaded area.

Now if I write it area A, B, C, D, E, F, G, H, then I can find it out influence factor DMO. DMO, this influence factor DMO, this complete plus OME, n, this is I, this is your n I OMO influence factor. I OMO state provide it is at the corner. DMEN, D M E N, DMEN. Sorry it is not DMEN, OMEN; that means, this is a O M E N, in this case it is straight forward at the corner. Plus CIOL, C I O L again perfectly fine this is at the corner, plus L O N F, LO N F. This is also perfectly fine plus A J O P, A J O P. This your p, A J O P. This is also at the perfectly fine, plus P O K H, P O K H, P O K H. This is perfectly fine, once you have considered because this strip, and this strip I am considering this area is coming twice.

Similarly, this strip and this strip I am considering this area is coming twice then it has to be deducted minus B J O L, B J O L minus L O K G, L O K G. This is how you are going to do it. I have only considered one of the point, point 1, one case I have consider. Next class I will consider 2 3 4 all typical cases and also, I will solve a problem.

Thank you.