Foundation Design
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Lecture - 18A
Earth Pressure Theories- Part 5

So, last class I have solved one problem considering layering effect.

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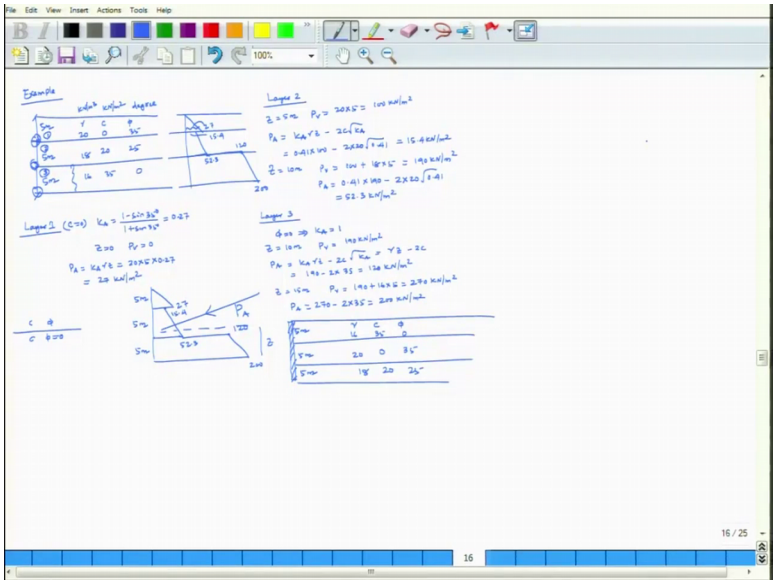

So layer 1 is 5 meter, later 2 is 5 meter, layer 3 is 5 meter. And first layer is gamma C n phi second layer is again gamma C n phi. Third layer is also gamma C n phi. First layer C is equal to 0, second layer phi is equal to 0. And I have given this as home assignment. You can try it, changing the properties. Now go to the example 2.

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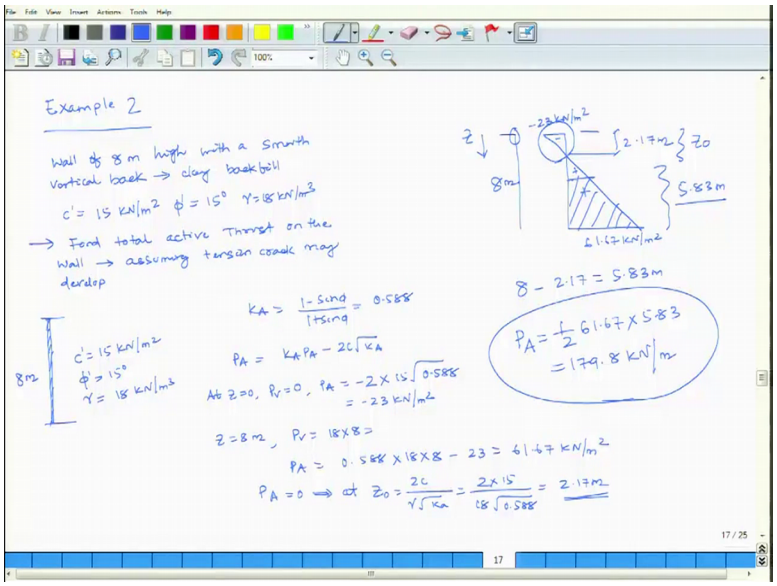

A retaining wall of 8 meter high with a smooth vertical back, smooth vertical back retain say clay backfill it retain clay backfill. The properties have been given C prime is equal to 15 kilo Newton per meter cube, phi prime is equal to 15 degree and gamma is equal to 18 kilo Newton per meter cube.

Calculate the total active crust what is the questions, find total active thrust on the wall on the wall. Assuming tension crack may develop. So, this is the case there is a wall. This is a wall of 8 meter high then the backfill is given this is your C prime is equal to 15 kilo Newton per meter square, it will be kilo Newton per meter square. Phi prime is equal to 15 degree. Gamma unit weight of the soil is 18 kilo Newton per meter cube. Now what is would be a k a? K A is equal to 1 minus sin phi by 1 plus sin phi which is equal to 0.588 and P A is equal to it is a cohesive soil.

So, it is K A into P A minus 2 C root over of k A. So, at z is equal to 0. Pv is equal to 0, then P A is equal to minus 2 into 15 and root over of 0.588, which is equal to minus 23 kilo Newton per meter square. At z is equal to 8 meter. Pv is equal to gamma into z 8 into 18 into 8. And P A is equal to 0.588 into 18 into 8 minus 23, which is equal to 61.67 kilo Newton per meter square. Again P A is equal to 0; that means, at z 0 which is equal to 2 C by gamma root over of k a, which is equal to 2 into 15 gamma is equal to 18 root over of 0.588 which is equal to 2.17 meter.

So, if I draw it, how it looks like; this is my wall. So, in this case here it will be at the bottom here it will be 61.67 kilo Newton per meter square, then here it is minus here it is plus, and this is your 8 meter height wall. Here it is minus 23 kilo Newton per meter square. And this height is your P A is equal to 0 this height is your 2.17 meter. This is how your earth pressure distribution diagram will come. Top will be negative because at z is equal to 0 means depth if I am considering this is my z, z is equal to 0 Pv particularly vertical force Pv is equal to gamma in to z.

So, z is equal to 0 vertical force Pv is equal to 0. So, P A will be minus 2 C root over of K A which is equal to minus 23 kilo Newton per meter square. And z is equal to 8 meter P B is equal to 18 into 8 because gamma is 18 and this is your 8 meter. And P A is your 61.67 kilo Newton per meter square at the bottom. Then it will vary from negative to positive, and with these negative value, we have to find it out at what point P A is equal to 0. So, P A is equal to 0; that means, at z 0, this is my z 0 which is equal to 2 C by gamma into root over of K A which is equal to 2.17 meter.

Now, total our p bar test if I can calculate it. So, it will be 8 minus 2.17, which is equal to 5.83 meter this distance is your 5.83 meter, because this negative. I have taken it out either you can do it take out the negative only consider positive part. For economical design here negative, here it is taking positive enter part has been taken only this part also to be considered. So, here I have taken out only negative part. So, then P A will be P A will be half this is your 61.67 into 5.83 which is equal to 179.8 kilo Newton per meter. This is my active stressed. This is my second example. So, 2 examples has been solved best on your Rankine’s theory.

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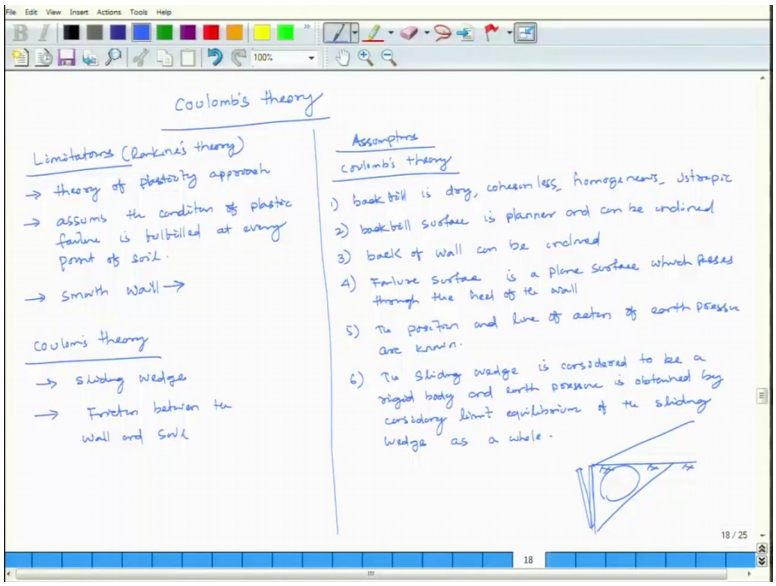

Now, let me go to if coulombs theory. So, what are the limitations of Rankine's theory; if I start with your limitations of the Rankine's theory, Rankine's limitations of Rankine's theory? So, limitation of Rankine's theories, theory of plasticity approach first one. It edges the theory of plasticity approach, second one is your, it assumes in Rankine's theory, assumes the condition of plastic failure is fulfilled at every point of soil. Again another one is smooth wall, smooth wall what is it mean smooth wall? That means friction between the wall and the soil is 0 that means there is no friction.

So, in coulombs theory in coulombs theory what they have consider; they considered the sliding wedge and second one also they have consider friction between the wall and soil. What are the assumptions; assumptions in coulombs theory. First one backfill is dry, cohesion less, homogeneous, isotropic. Backfill surface is planner and can be inclined. Backfill wall or back of wall instead of backfill let me write back of wall can be inclined. Failure surface in is a plane surface, failure surface is a plane surface which passes through heal of the wall.

The position and line of action, the position and line of action of earth pressure unknown; this sliding wedge is considered to be to be a rigid body. And earth pressure is obtained by obtained by considering limit equilibrium of the sliding wedge as a whole. So, what are the assumptions of the coulombs theory? The backfill soil is dry cohesion less homogeneous and isotropic. Backfill surface is planner backfill surface is planner

and can be inclined. If this is my wall if this is the backfill surface, it may be a planner or it may be inclined. Back of wall can be inclined if this is my wall it maybe vertical or it may be inclined.

Failure surface is a plane surface which passes through the heal of the wall, heal of the wall. Then position and line of action of earth pressure unknown, this sliding waves considered to be a rigid body. If I am taking a sliding waves this enters sliding waves considered to be a rigid body. And earth pressure is obtained by considering limit equilibrium of sliding wedge as a whole as a whole. Now let us consider coulombs theory active earth pressure.

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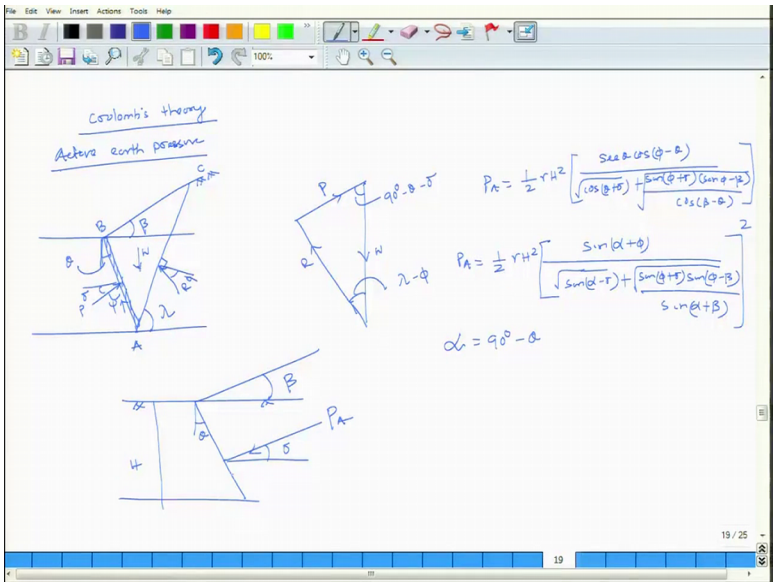

In active earth pressure, here it is beta, let us put it A then here B then here C. And this should be your theta, this is w and let this angle is lambda. This is reaction force, then this angle will be your phi this is normal force and this is 90 degree. Then there is a friction between the wall and the soil, and this makes an angle delta this is your p and there will be a psi.

So, this is how the width, this ways makes an angle lambda. This is my wall AB is my wall it makes an lambda with this vertical, then here and beta is the backfill is inclined. Then here this is a lambda failure surface is lambda, it makes an angle theta with your vertical sorry, it makes an angle theta with your vertical. Then please your pressure that because of your friction angle between wall and this soil that is your delta, and if I am

considering this is a wedge the weight of the wedge is w. And here is a reaction force. So, how it has to be solved? It has to be solved by means of force triangle. So, this is p and this will be a r and this is w. So, this will be 90 degree minus theta minus delta this isyour lambda minus phi. So, r is a reaction force, p is your force because of your delta. Angle between in friction angle between your soil, and the wall and w is yourself width because this post triangle has to complete.

So, this angle is your lambda minus phi this will be 90 degree minus theta minus delta; so considering this. So, P A will be half h square sec theta cos phi minus theta divided by cos theta plus delta root over plus sin phi plus delta, sin phi minus beta divided by cos beta minus theta it is root over. So, it can be expressed as it can be a also expressed as P A as half gamma h square into sin alpha plus phi divided by root over of sin alpha minus delta plus root of sin phi plus delta sin phi minus beta divided by your sin alpha plus beta. Then this is your whole square, when alpha is equal to 90 minus theta, if you look here where alpha is equal to 90 degree minus theta.

So, how it looks like if this is my wall, this is my ground surface and there is a wall inclined with this vertical at an angle theta. And this is your height h; so this mix beta. So, P A will be attained at an angle delta. Delta is what? Delta is friction angle between the soil and the wall and this is your height h. So, I am giving a typical value typical value of your K A for C is equal to 0.

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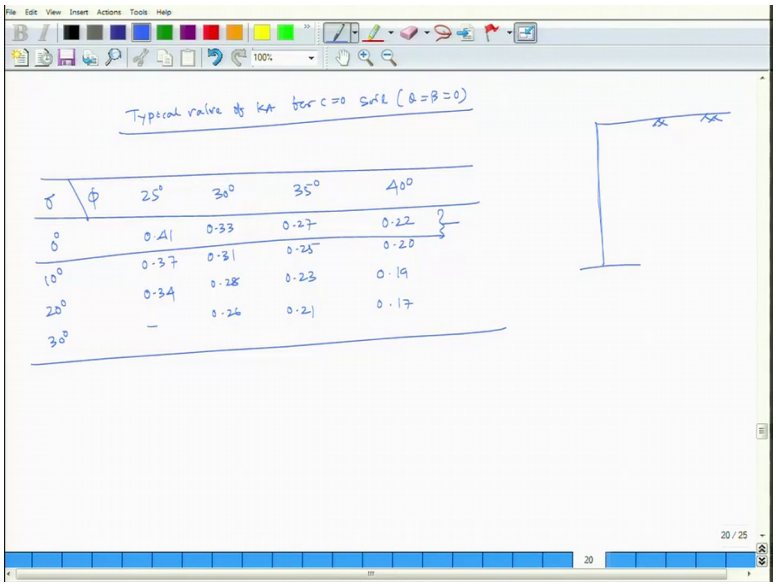

Soil where theta is equal to beta is equal to 0, theta beta is equal to 0, what does it mean? The wall is here, theta is equal to 0 means it is perfectly vertical, beta is equal to 0 means it is no more inclined rather it is a planner.

So, simple wall case, simple wall case what is the typical value of k considering coulombs theory? This is delta, this is your phi, which is 25 degree 30 degree 35 degree and 40 degree. And here delta is 0 degree, 10 degree, 20 degree and 30 degree. In this case 0 degree it is your 0.41, 0.37, 0.34, 30 degree 0.33, 0.31, 0.28, 0.26 35 degree it is 0.27, 0.25, 0.23 0.21 and this is your 0.22 and this is your 0.20, 0.19 and 0.17.

So, these are typical value of delta varying from 0 degree tot 30 degree. Once I am considering it is 0 degree, what does it mean; 0 degree means there is no friction wall is very smooth. And these value as per your Rankine's theory. Because it is 0 degree, then phi is varying from I have taken 4 values 25 degree 30 degree 35 degree and 40 degree. Delta is varying from 0 degree to 30 degree, and this is the range of the value typical value, if you consider beta if you consider theta also these values can be generated. This is your entire syllabus for your earth pressure theories.

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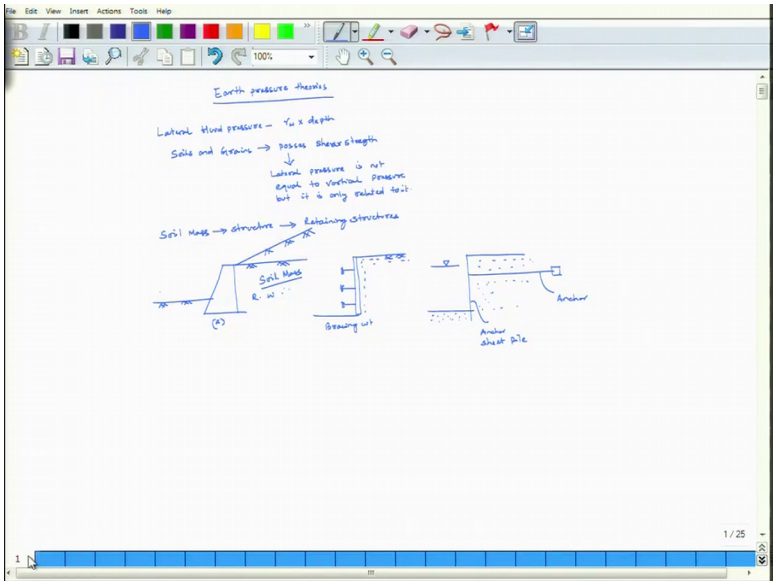

Let me summarize we have started with your earth pressure theories and considering for retaining walls because it has to retain the soils and in retaining your soils.

So, that is why where are the case retaining wall anchored sheets piles bracing based structures.

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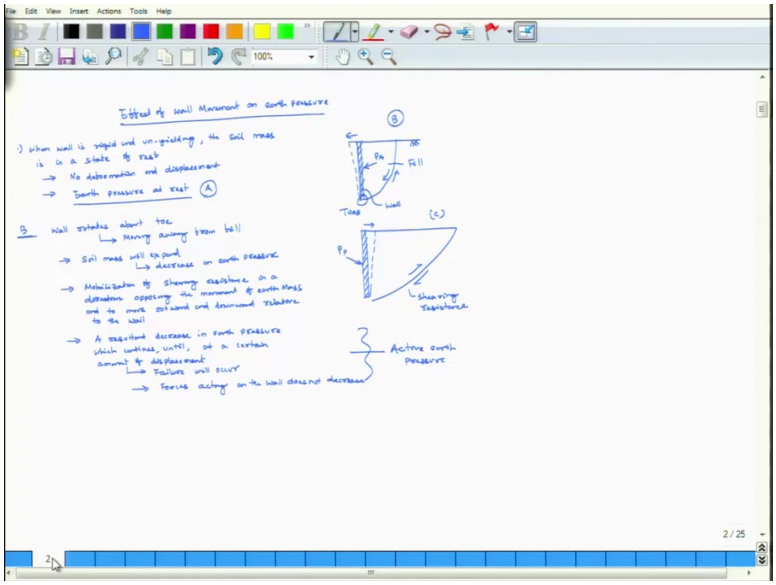

Then there are 2 cases, one is your no deformations or no displacement in that case it is earth pressure at rest. Then case 2 is your, one is moving away from the fill that is called active state moving towards this fill that is called your passive state. No deformation no displacement that is your earth pressure at rest.

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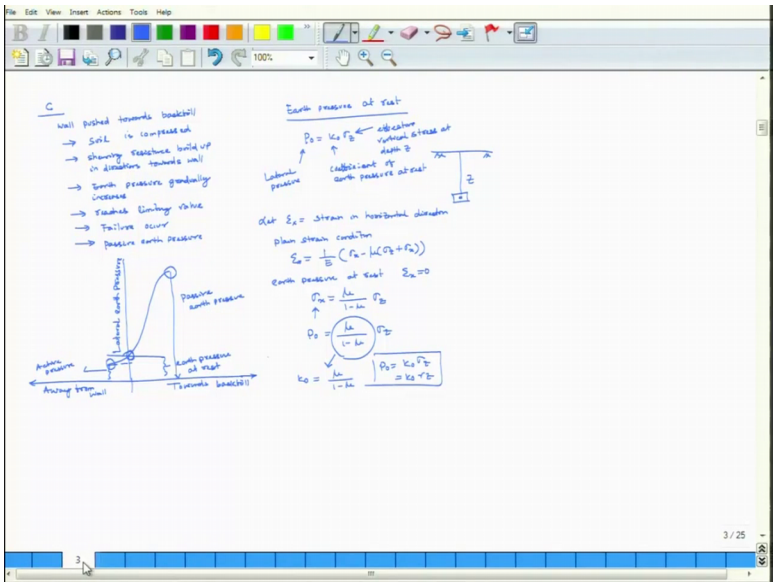

Then for earth pressure at rest we determine k 0 we depends upon your Poisson's ratio mu by 1 minus mu.

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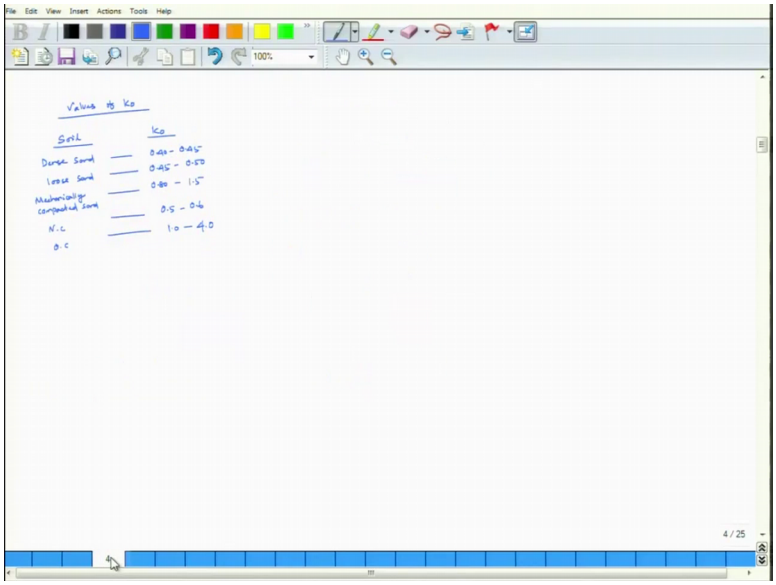

Then a different value of k 0 for soils has been given.

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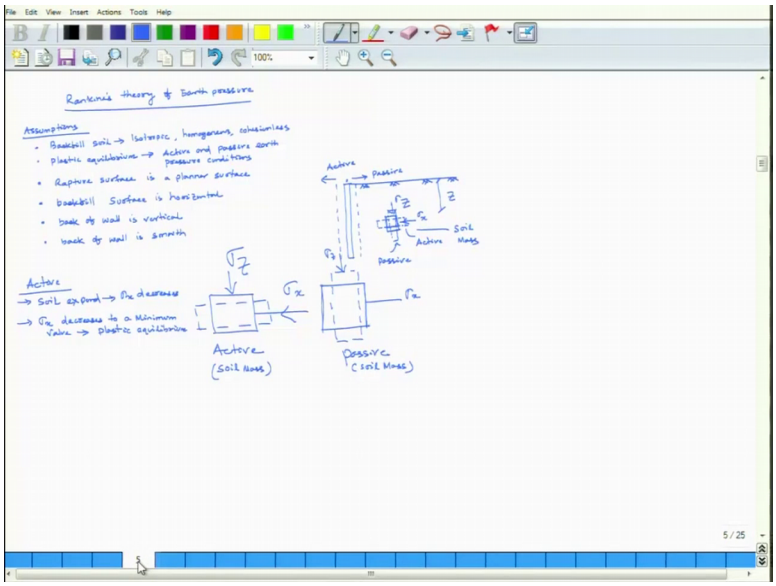

Then there are 2 theories, one is your Rankine's theory, other is your coulombs theory. So, Rankine's theory these are the assumptions. So, how this active state comes walls moves away from.

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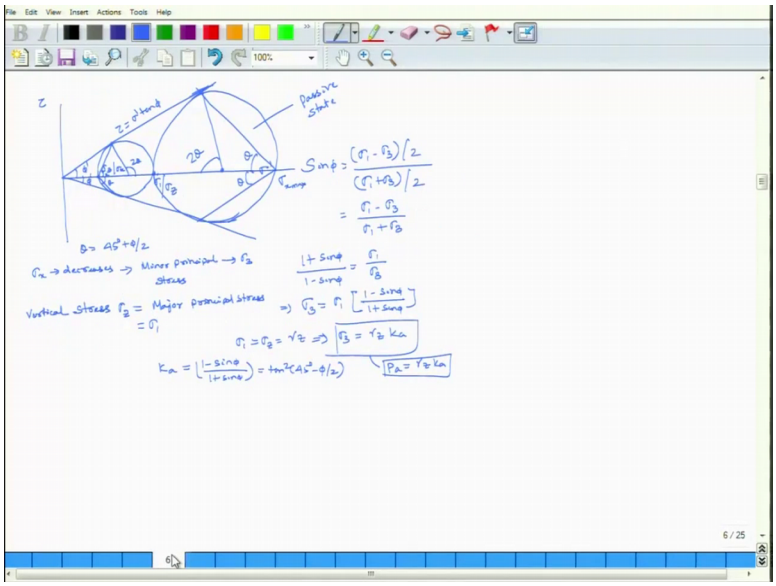

Then we have explained for active state and passive state, how the more circle looks like.

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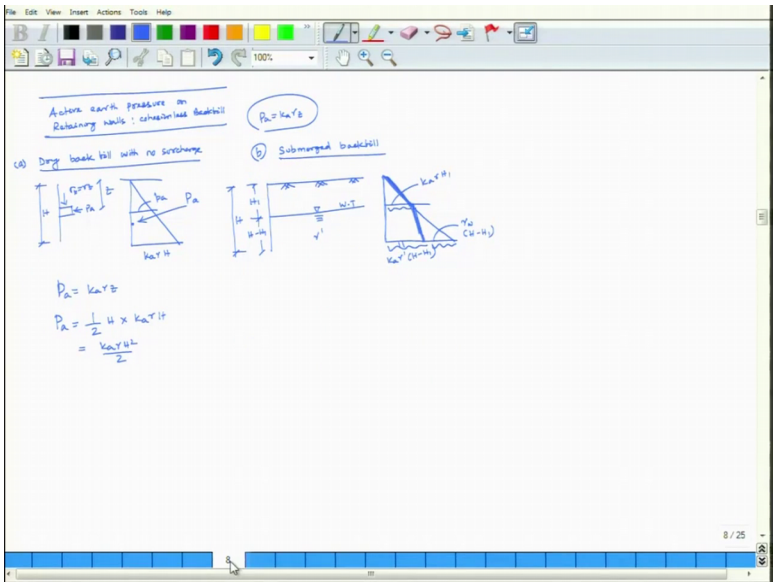

There active earth pressure on retaining wall for cohesion less backfill. 4 conditions I have discussed. Drive backfill with no surcharge, then submerged backfill, then effect of surcharge. Then effect of stratified soil in the backfill. Phi 1 gamma 1 and phi 2 gamma 2.

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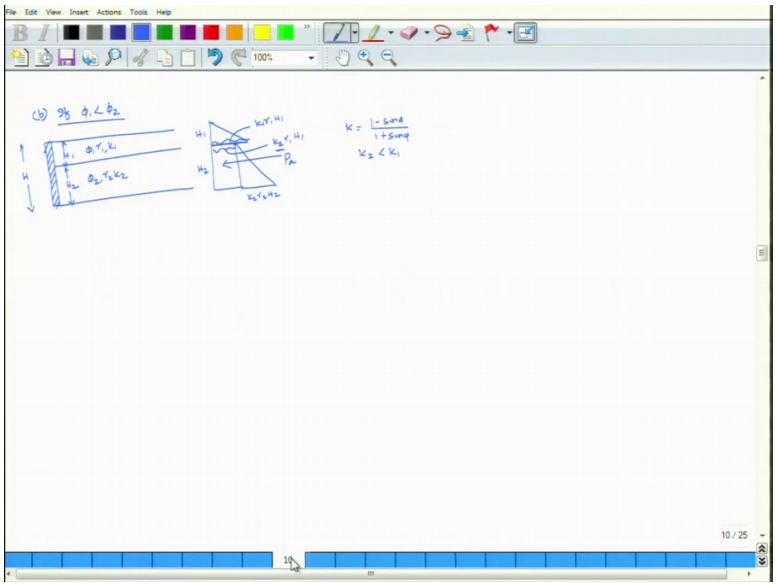

Then next one is your phi one, in case one stratified soil phi one is greater than phi 2. Second case phi one is less than phi 2. Then there are 2 examples, I have solved one example.

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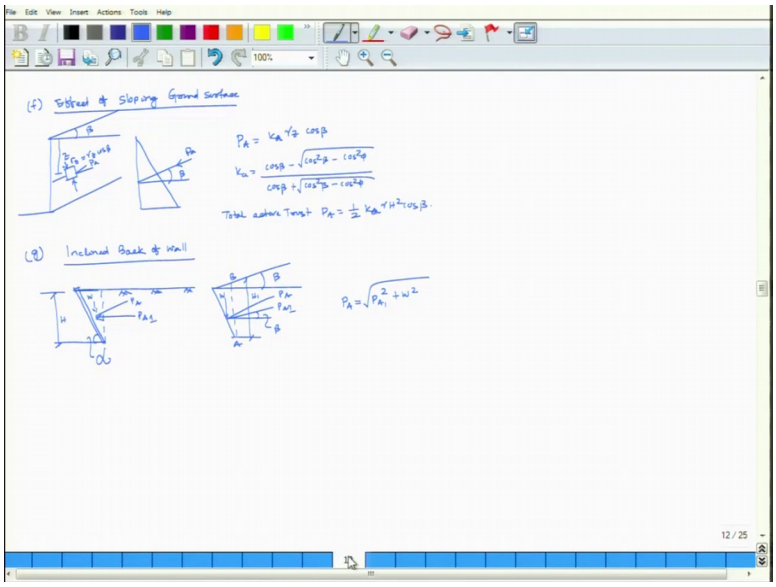

Then there is a case of effect of sloping ground, then there is a case of inclined back of the wall.

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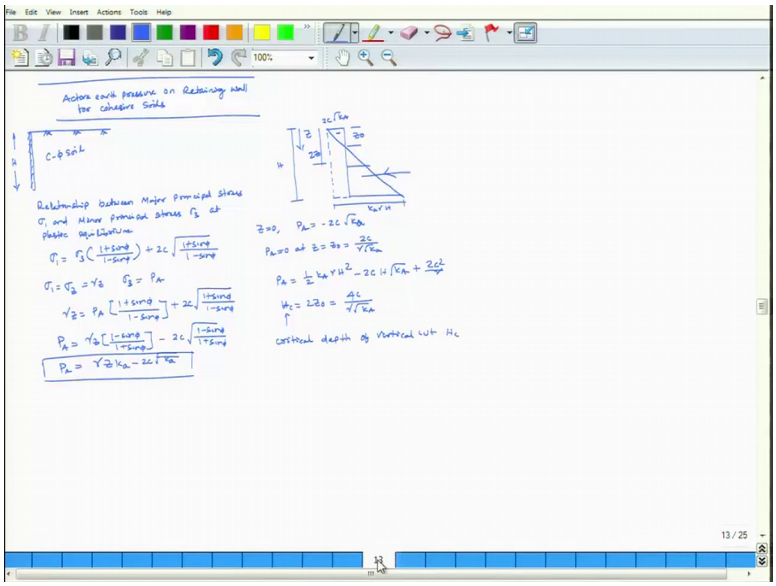

Then it has been extended for Rankine's theory or active condition for cohesive soils. And for cohesive soils P A is your gamma z K A minus 2 C root over of K A.

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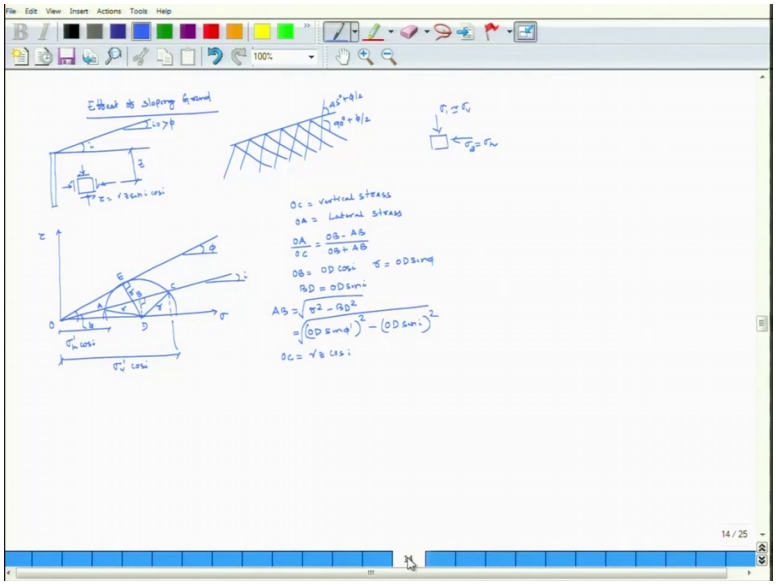

Then effect of Sloping ground we have derived, what is the value of K A? Then I have solved 2 problems for layer cases. Other case is your for cohesive soils. Then I have gone through your coulombs theory. What are the limitations of Rankine's theory then coulombs theory then what are the assumptions. How the pre body has been drawn this is a planner wedge and the force equilibrium from their P A has been calculated. Then a

typical value of K A as for the coulombs theory for C is equal to 0 soils and theta and beta is equal to 0. This is what is your earth pressure theories over.

So, next class I am going to start pile foundations.

Thank you.