Foundation Design
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Lecture – 16A
Earth Pressure Theories – Part 1

Now, next chapter I am going to start is your earth pressure theories. So, last class I have finished up to foundations particularly mat foundations, and different types of foundations almost all over except that structural design.

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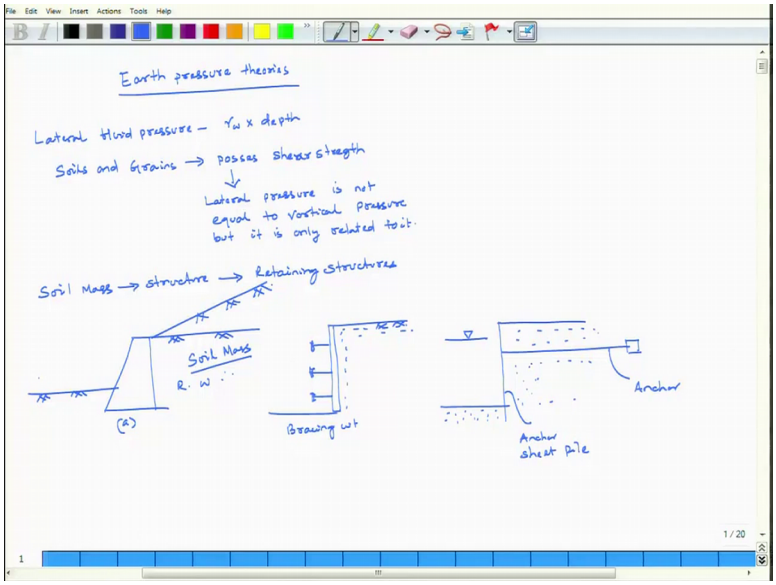

Now let us start with Earth pressure theories.

So, let me start with example lateral fluid pressure, lateral fluid pressure is equal to gamma W into depth: now soils and grains particularly if I if I do not go the fluid if I go by soils and grains. In this case posses shear strength it posses shear strength. Then what will happen? Actually lateral pressure in this case in not equal to vertical pressure, lateral pressure is not equal to vertical pressure, but it is only related to it, it is only related to it.

Structures which hold back soil mass, I can say structures which hold back soil mass. Particularly structures which hold back soil mass soil mass in a structure. That is called retaining structures. This is called retaining structures. So, again retaining structures various types retaining walls pile wall basement wall. Let me see let us see this

examples. So, this is your retaining wall, retaining wall what happen in retaining wall? One side it retain your soil mass in one side it retain the soil mass. Here ground has been elevated from this surface to this elevation to this elevation so that may be road can be elevated from here to here.

Part one a is your retaining wall. Second one for example, let take it. Bracing cot this is your bracing cot then anchors sheet piles in this bracing cot what happen this generally used particularly your (Refer Time: 04:37) or underground structures before if you go below this brace cot this side is your mass of soil mass. Then anchor sheet piles anchor sheet pile has been used generally in port and hardware structures, what happened here there is a water table here. Then your seat comes birth it here and people can go outside and this side is your soil mass.

So, particularly there is a soil mass which exerts on your anchor sheet pile, this is your anchor sheet pile. And this is particularly your anchor. Anchor has been provided in sheet pile to prevent bending due to your soil mass to prevent bending due to the soil mass. So, in this case soil can retain you can you can you can you can retain the soil mass here or you can retain the soil mass elevated from here, or you can you can do it here it any wall is there or you can do it in this case either side either you can retain this side or you can retain this side, if this is not the side you are going to retain if you are retaining soil mass in this side.

So, in this case it is not necessarily soil mass should be horizontal you can take a very strip flow also this way you can go for a strips flow. So, soil can be retain on one side of the wall and it exerts the pressures on the retaining structures on the wall. So, what kind of pressure that we are going to discuss? So, this is about your earth pressure theories starting this, let me start with this effect of wall moment on earth pressures effect of wall moment on earth pressure.

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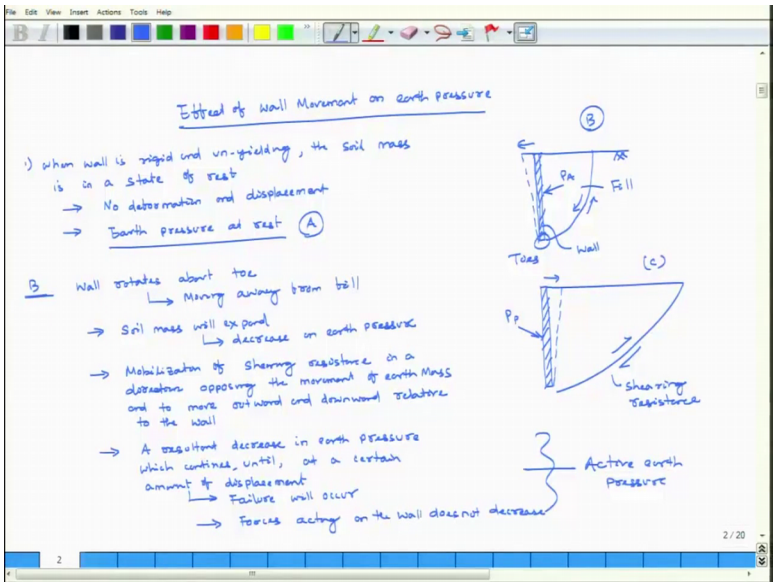

So, let me let me put it particularly when wall is rigid and unyielding, retaining wall is rigid and unyielding, it is neither yielding in translation rotation or any of the mode the soil mass, soil mass is in a state is in a state of rest. In that case soil mass is in the state of the rest what will happen? Particularly this case there is no deformation and displacement. And earth pressure corresponding to this state is called earth pressure at rest.

So, first one is your earth pressure at rest, if you look at here first one is your earth pressure at rest. What is it mean when wall is rigid, and unyielding this soil mass particularly in that soil mass in the wall prefer the wall in the state of the rest in that condition what will happen? There will be no deformations as well as displacements, so that condition we call earth pressure at rest.

Now, let me put it 2 figures let me draw 2 figures it will be more clear to you, this is one. So, there is a wall here wall is if I say this is my wall, wall is moving away from the fill. This is fill, this is one wall is moving away from the fill. So, in that case it is called active straight I wrote it P A. Let us say there is another wall. This wall is moving towards the fill means, this is the moment of the wall, this is the moment of the wall, this is the moment of the wall. Wall is their moving towards the fill.

Look at the diagram how this shearing resistance are and this will be your Pp. Let me start it first one, this is the case one, this is the case b case 2, this is the case 3. Let me

start with this first one I have finished case 2. Wall rotates about toe in this case wall rotates about toe so; that means, what does it mean it means moving away from fill. Then the soil mass expand what will happen? Suppose there is a wall here there is a soil mass and it is moving away.

So, this soil mass will be expand. Then this soil mass will expand. So, it results decrease in earth pressure, it results decrease in earth pressure, mobilization of shear resistance in a direction opposing the moment of earth mass, look at here, mobilization of shearing resistance in a direction opposing the moment of earth mass; and to move downward and outward relative to the wall, downward relative to the wall.

So, what will happen? First wall rotate about the toe this is my toe wall rotate about the toe. So, because wall rotate about the toe; that means, what will happen it will moving away from the fill. So, inside the soil mass that will expand; that means, decrease in earth pressure, mobilization of shear resistance in a direction opposing the moment mobilization of shearing resistance in direction opposing the moment because it is coming here if you look at it is opposing the moment.

Then there is a resultant a resultant decrease in earth pressure a resultant decrease in earth pressure which continues until at a certain amount of displacement failure will occur in the wall fill and sleep surface will be then what will happen? Failure will occur. So, after that after failure has been occurred. So, forces acting the wall does not decrease.

Forces acting on the wall does not decrease. So, what does it mean? Even if there is further moment of the wall the forces acting on the wall is not going to decrease. So, this is called this is called your active earth pressure. Similarly if I go let us say similarly the wall is push towards case c, if wall is push towards this your back fill what will happen? Let us say case c.

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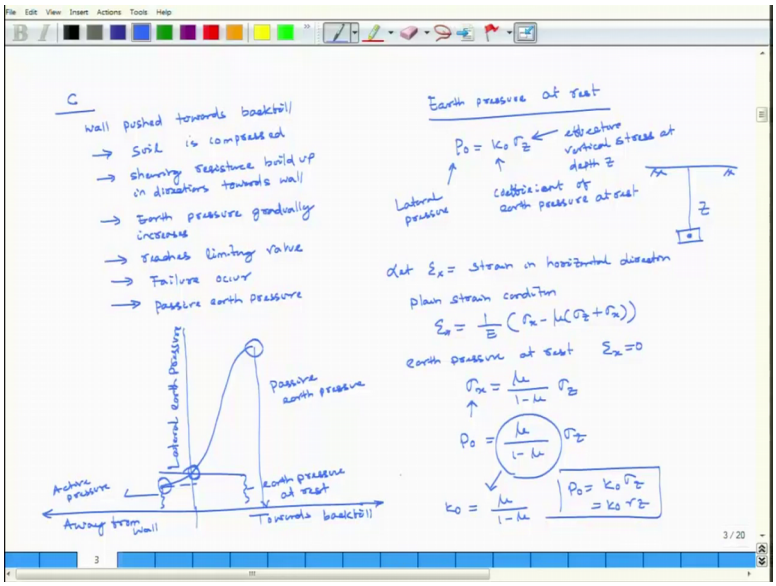

Wall pushed towards back fill. Then what will happen? The soil is compressed, soil is compressed and this shearing resistance built up in the direction towards the wall.

Shearing resistance built up in directions towards wall. Then what happen? Earth pressure gradually increases, earth pressure gradually increases. And it will reach it is limiting value, it will reach it is limiting value reach it is limiting value, then your failure occur. This is called your passive earth pressure this is called your passive earth pressure. If I draw how it looks like if I draw a very simple way, this is my lateral earth pressure, I can put it lateral earth pressure. Then if I am drawing it particularly this point, this is your active pressure. And this part is earth pressure at rest. And this will be from here to here it will be passive earth pressure.

So, I can write it here it is away from wall and it is your towards back fill this is away from the wall this will be your towards back fill. If I put it draw the lateral earth pressure. Then if you look at passive earth pressure is much higher than your active earth pressure active earth pressure generated because wall moves away from the fill. Passive earth pressure generated because wall moves towards the fill. If I put it in a 3 parts one is your earth pressure at rest in earth pressure at rest there is no deformation and displacement.

Second is your active earth pressures when wall rotate about the toe at that time wall moves away from the back fill, that is called active earth, that is called second case b where is your active earth pressure condition; that means, wall is moving away from the

fill. If wall is moving away from the fill, this shearing resistance to resist it look at the directions it will be the opposite directions. So, then it will reach it is limiting state failure will occur. So, at that condition that is called your active earth pressure.

Similarly, in case of passive state wall is moving towards the fill, if wall is moving towards the fill, this shearing resistance is again opposing direction opposite directions. So, in that case in that case what will happen? Earth pressure increases gradually then it reaches up to the limiting value then the failure will occur. That is called passive earth pressure. If I draw in a diagram this is my earth pressure at rest, this point is earth pressure at rest, this is your passive earth pressure, this is your active earth pressures.

Now, next part is your earth pressure at rest, earth pressure earth pressure at rest. So, if you put it at rest conditions. So, p 0 is equal to p 0 is equal to k 0 sigma z. Sigma z is your effective vertical stress, vertical stress at depth z. K 0 is your coefficient of earth pressure at rest, coefficient of earth pressure at rest. Then p 0 I can write it that is called your lateral pressure. If I take it this is my ground surface at depth z there is a soil element here.

So, at that point the p 0 lateral pressure is equal to k 0 into sigma z. Sigma z is your effective vertical stress at depth z. K 0 is coefficient of earth pressure at rest let epsilon x is equal to strain in horizontal direction at depth z, strain in horizontal direction at a depth z for a plane strain condition for a plane strain condition epsilon x which is equal to one by e into sigma x minus mu sigma z plus sigma x.

So, earth pressure at rest means what is it mean there is lateral deformation; that means, earth pressure at rest epsilon x is equal to 0. Then in this case sigma x is equal to mu by 1 minus mu sigma z. So, if I write it sigma x is equal to lateral earth pressure p 0, which is equal to mu by 1 minus mu sigma z. Then this is nothing but is your k 0, k 0 is equal to mu by 1 minus mu; that means, p 0 is equal to k 0 sigma z which is equal to k 0 gamma z.

So, earth pressure at rest it depends on your possions ratio of the soil that is your mu is your possions ratio mu by 1 minus mu. So, p 0 is equal to k 0 into sigma z k 0 is your coefficient of earth pressure at rest k 0 is equal to mu by 1 minus mu. So, p 0 is equal to k 0 sigma z, where as p 0 is equal to k 0 gamma z. So, value of value of your k 0.

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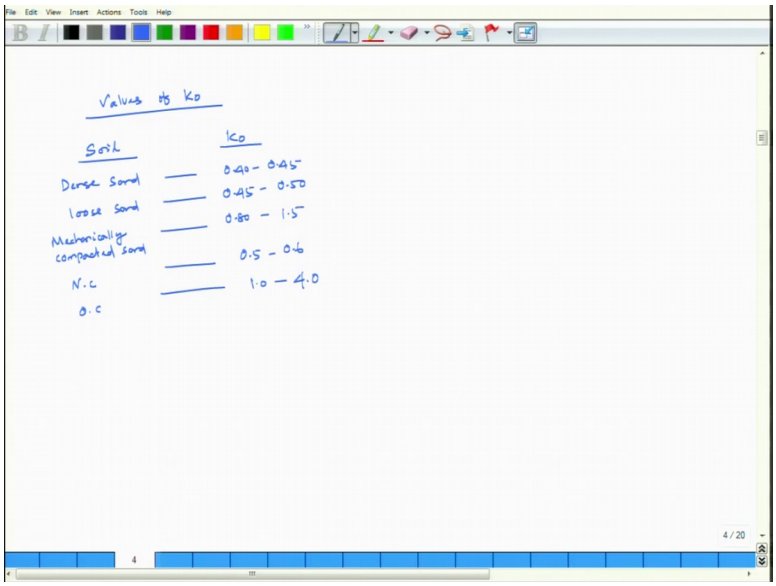

Values of k 0 if I put it write it soil, here it is your k 0 dense sand. Dense sand it will be 0.40 to 0.45. Then loose sand it will be 0.45 to 0.50. Then mechanically compacted sand it will be 0.8 to 1.5. Then normally consolidated clay N C it is your 0.50 to 0.6. Then over consolidated o c over consolidated clay it is 1.0 to 4.0. This is standardized for soil if it is earth pressure at rest what is the value of coefficient of earth pressure k 0 dense sand 0.40 to 0.45 loose sand 0.45 to 0.50 mechanical compacted sand 0.8 to 1.5. Normally N C is your normally consolidated clay this is your 0.50 to 0.6. Then o c is your over consolidated clay this is 1.0 to 4.0. I think I will stop it here then next class I start in details about the earth pressure theories rankines and coulombs and detail procedures.

Thank you.