Application of Soil Mechanics
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Lecture – 01

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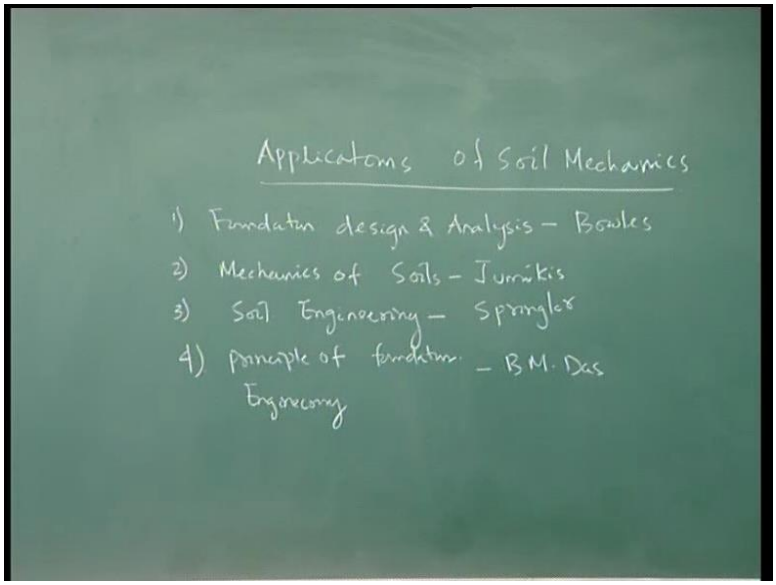

In this course, this is application of soil mechanics. This is basically all applications of basic soil mechanics; and in this course, the books of particularly followed one is Foundation design and Analysis by a Bowles, then Mechanics of Soils by Jumikis, then Soil Engineering by Springler, and Principles of Foundation Engineering by B. M. Das . So, in an way, these are the books particularly followed in this course, and this books has been referred particularly this course.

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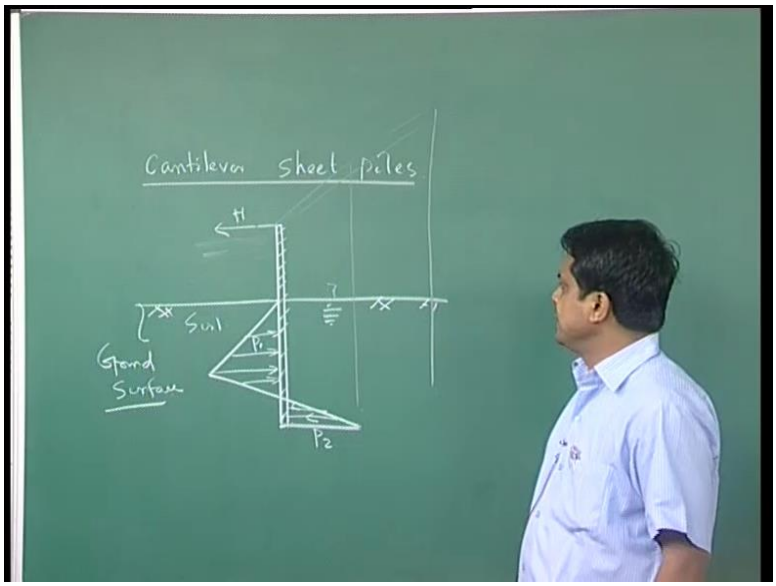

Let us start with these piles - sheet piles (cantilever sheet piles). If I draw a cantilever sheet pile, now where it has been use this cantilever sheet pile, if this question is where it has been used, then you can say particularly in offshore structures when the sheet is coming and budging cantilever sheet pile has to be connected by this. So, once if this is my water table somewhere else is water table here or this side or this side may be soil here it is soil if this is the water table. So what will happen, once this ship is coming, ship has to stop somewhere else and budging and people should come out, and this is your ground surface. So, people has to come out this is one case means particularly this cantilever sheet piles has been used in case of offshore structures as well as particularly onshore structures means ports and harbours, this cantilever sheet piles has been used.

Now, sometimes either you can provide this is your sheet pile, this is your cantilever sheet pile why it is called cantilever, the centre load has been taken by this cantilever action of this sheet pile, and it has been embedded inside this ground surface of this soil below this. So, what will happen, it will take this centre load coming here will be taken by this cantilever sheet pile by means of cantilever action by means of cantilever action that is why it is called cantilever sheet piles. And once again, it has been use particularly port and harbours, offshore and as well as onshore structures it has been used.

So, this cantilever sheet pile may be it can say that anchor or without anchor, if I sometimes what happen if the bending moment is much high, so what will happen to

rigid this bending moment or rigid the moment at top of the cantilever sheet pile to stop the failure sometimes anchor has been provided. So, there are different modes of failure depending upon that how the cantilever sheet pile is there, one is rigid, other is flexible. So, depending upon that means, in this case what happen this anchor has been provided to your cantilever. So, this is called anchor sheet piles. Anchor sheet pile if anchor hedge not been provided it is simply called cantilever sheet piles.

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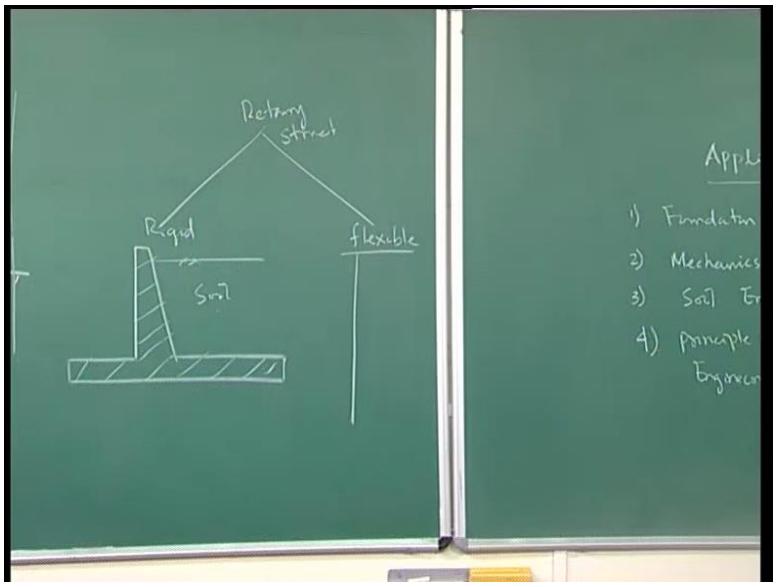

So, these are particularly this sheet piles and others these are particularly to retain this soil mass one end, and other end is that it has been used for particularly port and harbours. If I go these two parts, one is your rigid walls and another is your flexible walls. Retaining of this soil, I can say that retaining structures so that means, in the this retaining structures what will happen at one part of this wall, this soil has to be retained, so that is why it is called retaining structures. So, this retaining structures are called sometimes rigid retaining wall or rigid wall or flexible wall. So, rigid walls are called retaining walls because this is a massive and it will fail by means of rigid, its rigidity is very high.

Other one is called flexible. This flexible is nothing but is your sheet piles, and it will take load by means of cantilever axon, it will takes by means of cantilever axon we can say that cantilever sheet pile, it will resist the load by means of anchor you can say that cantilever anchor sheet pile. So, depending upon that classification will be there. So,

retaining structure I can made it into two parts one is your rigid, other is your flexible. So, flexible next next class I will show you what are the things and rigid what are the things. So, basically two parts retaining of the structures means it will retain the soil mass at one end, it will not allow the soil mass would be get disturb or may be soil mass should be eroded, particularly it will retain one side. So, if it is purely rigid this structure then it is called rigid retaining wall or may be retaining wall. If it is flexible in nature, so it is called sheet pile or anchor sheet pile depending upon that functions how it works.

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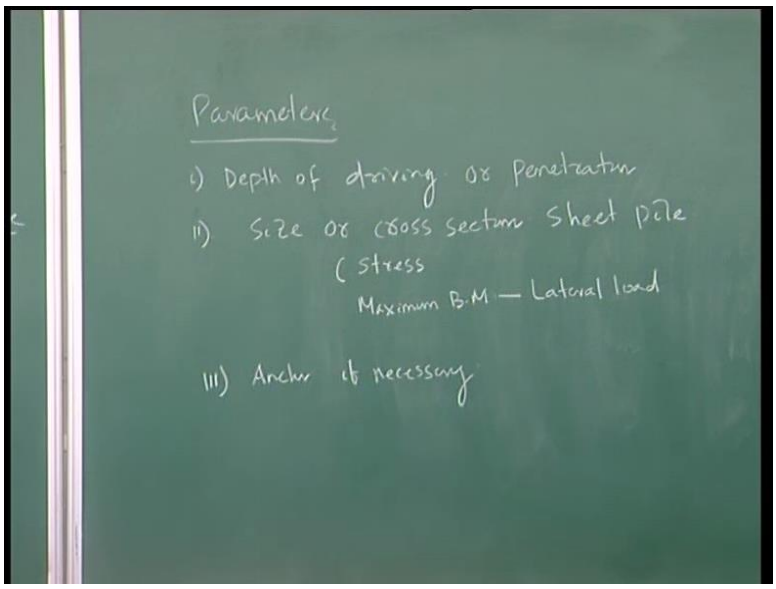

Now in these case before I go in detail what are the different analysis and others and classification. So, let us start with this basic physics means basic mechanics of this cantilever sheet piles. What we want to find it out what are the parameters from these cantilever sheet pile once I am saying that what are actually parameters required to be determine? So, parameter one is your depth of driving or penetration, then second is your size or cross section of sheet pile. Then in these case, size and cross section of sheet pile what you are suppose to find it out, you are suppose to find it out stress, maximum bending moment, and by maximum bending moment because of your lateral load, then third is your if you provide some anchor may be anchor if necessary.

If you look at this cantilever sheet pile then why first part is where this sheet pile has been used. As I said earlier it has been use particularly for harbours dock and harbours. So, where the ship will come and rest and people can come out. So, one end what will

happen one end ship will be tied if ship is budging here this will be tied here. So, that people can come out outside. So, this is the purpose where it has been used this the purpose first one.

Second part is if it has been used then what are the different parameters we are suppose to find it out. The different parameters is that depth of driving or penetration means below this surface I will not say this is exactly ground surface because this water table ground surface somewhere else. The definition is that this is your degrade line brace line that will tell later. So, what is that depth how much depth it should be penetrated below this level, so that whatever the inter load is coming at the top it will be taken by below this level, so it will be stable. So, this is fast and foremost criteria means parameter to be determine.

Then size and cross section, why we need size and cross section, because depending upon the size and cross section what is the stress induced on this wall. How much stress induce and what is the maximum bending moment, because depending upon the bending moment you can find it out, how the moment will come whether, it is within this permissible limit or not with respect to a lateral load. Then this size and cross section depending upon that you will have to find it out these two stress and maximum bending moment.

Then other one is an anchor, if you provide anchor, if suppose this bending moment is very high or means very high value of moment you are getting, so it will fail by means of bending then what happen as I said you will have to provide anchor. If you want to provide the anchor then what should be its capacity at what depth you are going to provide. Suppose I provide the anchor here, now what is its capacity, anchor capacity then up to what depth means up to what length this anchor should be provided. So, that it can take your bending moment. It can take your bending moment. So, these are the parameters we are going to determine from this cantilever sheet pile walls.

Let us start before going to classification, let me start with a brief of cantilever sheet pile walls, then will go to the in details backward about this classifications. Now we will come back to this there are two soils either it may be a purely granular that means, cohesionless soil or may be cohesive, sea pile soils.

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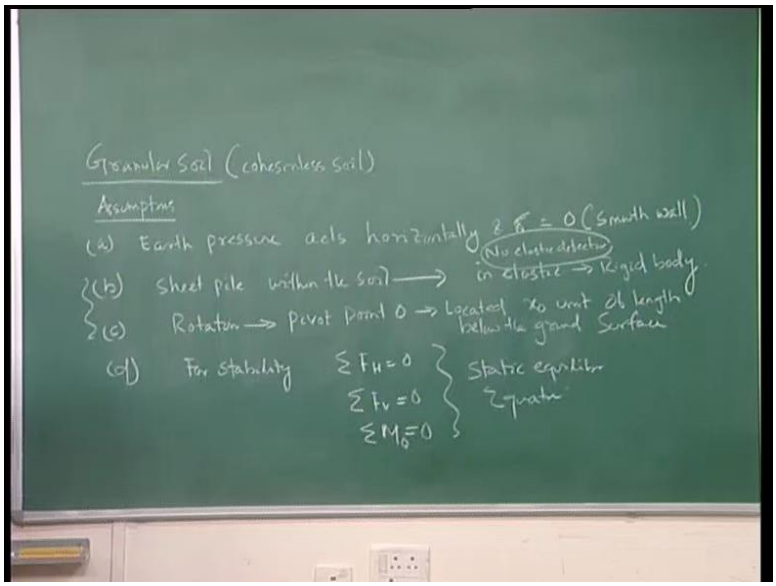

For granular soils, what are the assumptions, because this has to be theoretically analysing theoretically you have to analyse then find it out what is its capacity. So, that it can take this amount of load. So, with that suppose if I know theoretically if I know suppose this is my height h depth of the penetration. If I know the soil property of the pile, I can find it out the capacity based on that I can say that what is its maximum lateral capacity this sheet pile can take, so that whatever the ship and others they are budging how much the capacity will they have that can be said ok. This sheet pile wall can take maximum of two turn one turn three turn five turn for metal length. So, depending upon that other parameter has to be also determine or may be fixed.

So, assumption is earth pressure acts horizontally and angle of friction angle friction between the wall and the soil this is called delta. So, delta is zero delta is zero what it will mean fast assumption is earth pressure acts horizontally; that means, it is not a curve earth pressure, this is a simple earth pressure act horizontally. And second part is your delta is suppose to be zero first one is simple assumption delta is zero; that means, friction between wall and soil should not be there; that means, this walls should be assumption is a smooth wall, it is a smooth wall.

Then assumption second assumption sheet pile within this soil, it is consider to be in elastic that this it is a rigid body. Then third assumption is if it is a rigid then for particularly this is for these are the assumptions has been taken for particularly granular

soils; that means, granular soil means it is cohesionless soil. So, there is a rotation called pivot point o that means, it is assume once there is a this load is there that this is rigid. So, what will happen it is not flexible this is a rigid wall. So, it will rotate somewhere else the wall will rotate somewhere else some point. So, this is called o or this o point is called a pivot point, where the wall rotate this is called pivot point.

So, it is located x zero unit of length below the ground surface that means, this is at a distance of x zero below the ground surface. Look at the assumption three assumption two and assumption three; that means, sheet pile within the soil mass, if you look at the soil is here the sheet pile within the soil mass; that means, below the soil mass, it is in elastic; that means, no elastic deflection. So, no elastic deflection means, it is a rigid body.

So, the moment assumption two followed sheet pile one for particularly granular soil within this soil mass, it is rigid body the moment will follow what will happen second part will come that if it is a rigid, so it will rotate somewhere else. So, the moment you say that it is rigid the sheet pile is within the soil mass particularly granular soil is a rigid body that means, there will not be any deflection. It means there is a rotation this means this wall will rotate some point that is called point o and this point is called pivot point, and it is located at a distance x zero below this, where the soil starts it is located. So, these two assumptions are main assumptions.

Then fourth one is also that is also important for stability. For stability analysis, for stability equation of static equilibrium is to be applied. What does it mean, equation of static equilibrium; that means, summation of forces in horizontal direction summation of forces in vertical direction and summation of moment at point o is equal to zero. Summation of forces in horizontal direction summation of forces in vertical direction summation of moment at point o at the pivot point for stability that means, the equation of static equilibrium has to be satisfied; that means, static equilibrium equation has satisfied for stability. So, these are the main four assumptions for particularly granular soil or cohesionless soil has been used.

First one is your earth pressure act horizontally, it is horizontally means it is not curved one earth pressure is simple horizontal, it is not curved one. Then the friction angle between the wall and the soil this is called delta is equal to zero; that means, the wall is a

smooth wall this is your second assumption. Third assumption is your sheet pile within the soil; that means, sheet pile below the soil mass assume to be a rigid body for particularly cohesionless soil. Once it is a rigid body, that means, it will not deflect; that means, what will happen it will rotate at a point o below this soil. This point of rotation point o is called pivot point this is called pivot point. Then one there is a rotation, there is a pivot point then these distance of this pivot point should be at a distance x zero below the soil not below the ground below the soil.

If I say this is my ground surface because once there is ship is there it has to be budge. So, this is the ground surface, they are going out these may be full of water, no actually where this soil soil mass starts of the foundation soil starts below this up to to the pivot point, it x zero or any distance that has been said x zero. Then fourth one is your for stability analysis, forces in horizontal direction, forces in vertical direction and moment about point o should be zero, this is called stability analysis; that means, static equilibrium has to be satisfy. For stability analysis, static equilibrium has to be applied and it has to be satisfy; that means, any imbalance force has to be balanced and put it into zero and you can get it. So, these are all four assumptions.

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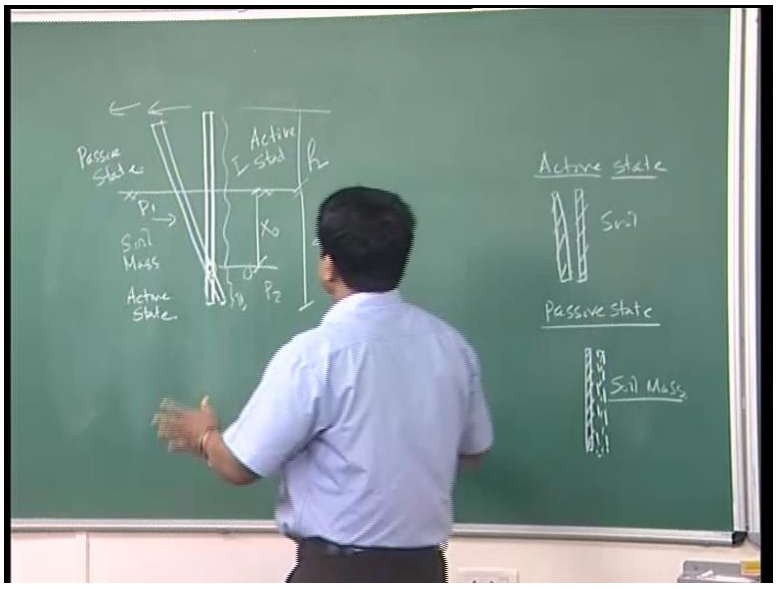

Now let us understand the mechanics of these cantilever sheet pile inside the granular soil or cohesionless soil. This case one, say a inside the cohesionless soil. So, what will happen as per the assumption be a second assumption, it is a rigid body because of rigid

body it will rotate some point - point o, and this point o will be located at a distance below this soil. This is your soil mass at a distance x zero. So, if this is my point of rotation or o pivot point o. So, what will happen it will rotate; that means, what exactly happen, look at these, what exactly happen. Now if I say this is x 0, and say this is called P 1 and this is called P 2. So, this is say point d and this is a point h, now what you understand, how the mechanics, how you are going to find it out you can look at this.

This is a wall, suppose this is a wall, this wall has a rotation point point o and below this is a soil. What will happen you know earlier what is active state, what is passive state. It is basics soil mechanics active state and passive state because this is an application of soil mechanics. So, active state is if there is a wall, if this is a wall for retaining of soil, if this side is soil, if the wall is moving away from the soil mass, the pressure generated by soil to the wall is in active state or active earth pressure.

Similarly in case of passive state, if this is the wall, and it is the soil mass, if this wall is here what happen moving away from the soil mass. If this wall is moving toward the soil mass; that means, it is moving toward the soil mass, so what will happen the pressure generated by soil is nothing but is your in is is in passive state or passive earth pressure. These are the two basic things we are going to apply, this is your soil mechanics for active state and passive state. If you look at here; that means, top part of this, take this there are two part because there is a point of rotation - part one, and below the point of rotation this is a part two. So, part one these part is moving away this is your soil, this part is moving away; that means, this is your active state from o to this, because this is moving away. At the other end, it is moving towards this side of the pile, it is moving away, these side of this it is moving towards; that means, this will be in passive state.

Now, if you come back to here, below the point of rotation this part is moving away from the soil mass, because it is from here, it is going like this moving away means this is in active state. And from here to here, this part is moving toward the soil mass so that means, this is in passive state. So, if you look at this basic physics behind it, the top part of active state and passive state is in reverse order of the bottom part. So, what will happen will see how this mechanics, how it has been derived, we will see it.