Geotechnical Engineering - II

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Lecture No. 42

Cantilever Sheet Piles

So, many times there are installation of cantilever sheet piles in different types of soil deposits. Now the most prominent type of a situation is when you have a sheet pile and then this sheet pile is sitting in sand and the backfill is also a sandy material. So, this is also sand, and this is the foundation layer which is also sand and somewhere here you have a water table. Height of the wall is H, height of the water table is h_w. This is D, draw the pressure diagram. The first thing, you can do it. Up to here is P_1 then P_2, now what is going to happen? There is a switch over. So, switch over from P_2 to some other value. For the sake of convenience, I am just improving the length of the sheet pile.

What is going to happen further from here? So, suppose this is P_4. And P_3 is some fictitious term coming over here, what we have to do is we have to obtain P_1, we have to opt in P_2, we have to obtain P_4. And the P_3 which is a fictitious term over here. So, this is a situation when you have sands as the foundation of the sheet pile or the embedment and the sands as a backfill material also. So, you can compute P_1 if I give you the values like γ, γ' and what else is required.

Suppose z_1 is known, z_2 is known and then I can divide this geometrically in different different parts, let us say this z_5, this is z_4 and so on. So, $D=z_4 + z_5$. The basic concept here is what is the magnitude of the P_3. So, this is active pressure, and this is a passive pressure. So, $P_4=P_P- P_a$ at point C. That is the only thing which you have to obtain. So, we can obtain P_1 easily, P_2 easily. What about the P_3? P_3 there will be a difficulty in obtaining, but.

Suppose if I say that this is equal to the entire thing is in K_P condition, passive condition, is it not? So, you have to compute the value of P_3. Just see how much it would be? Find it out. P_3 and then obtain the value of P_4. You can obtain it easily. So, this is a situation when we are dealing with sands over sands.

I can easily convert this into a situation where you are dealing with let us say I can still maintain the backfill as sands, but the foundation material becomes clays. This is a slightly tricky situation. So, what is going to happen in this situation? The pressure diagram would be any guesses? There is a water table over here. So, the pressure diagrams up to this point is easy to obtain. What happens at this point?

Now, you have touched the clays, what is the pressure at z=0 and this is active situation or passive situation? You have to think of that. So, how the pressure diagram would look like? The pressure diagram would be, there will be a pressure which is constant over here and then there is a switch over.

So, something of the sort and this goes and meets the tip over here. So, this is how the pressure diagram looks like. This is the most critical thing. So, this will become 4 seat. Why 4c? This is P_P minus P_A. So, γz plus 2c and minus of this whole thing multiplied by K_a minus 2c. So, this will become 4c term. So, that means, I can obtain this also and what about this? The total depth and then this is going to be a different between K_p-K_a. Is part, okay? You will have to practice this.

The third situation could be where I can make the whole thing more complicated when you have backfill also has a clay. Suppose there is a backfill which is of clay material and the foundation is also clay, so what will be the difference? When you deal with the clays, what about this portion exposed to the environment? No external loading. So, this is your 2c components, tension crack and this becomes z_0. So, truly speaking this portion of the wall does not experience any pressure because of being a clayey material.

First of all, clay should not be used as a backfill material. But here what we are doing is, it is a natural ground where we have inserted the sheet pile and then we have dredged out the soil mass to attain this much of embedment. It is not the other way. So, the moment you do this, there is a possibility of tension crack developing over here, this much portion of the wall does not contribute or does not experience any pressure from the soil mass and this is going to be very detrimental because the rainwater will come and sit over here and that will apply pressure on the top of this and then you are seeing the moments are going to get increased.

Is this correct? So, rest of the things will still remain same what we have analysed in the previous case. Only thing is this part has to be taken care of. This is a beautiful example of how to incorporate the effect of tension crack when the backfills are cohesive. So, with this I am going to close the discussion on the sheet piles analysis and one more concept which I wanted to highlight is this what is known as the effect of arching action.

So, arching is known as a phenomenon which is pressure distribution. So, whatever we have been computing so far by using the Rankine's earth pressure theory in different cases of the retention of the backfill material and the foundation material. This is all theoretical. Now, if you do the field studies and if you measure the stresses, how do they vary in the backfill or behind the retaining wall the situation is going to be different. Truly speaking, what is going to happen is if you have the sheet pile over here, what has been observed is that on the passive side if the theoretical pressures are like this. This is as per Rankine's earth pressure theory, theoretical pressure distribution.

Truly speaking, in real life the distribution of the pressure has been observed to be something like this. So, this is the real pressure experimentally obtained pressure. The difference between the two is because of the arching action. That is the pressure redistribution in the soil must which is violating the theoretical concepts which you have studied so far. Is this part, okay?

Now, similarly, on the active side, what is going to happen is if you plot the theoretical distribution of the pressure, this is how the Rankine earth pressure would be. There is a deviation and what has been observed is the maximum pressure gets mobilized somewhere in the top surface. It reduces becomes zero at the DL- dredged level and then again it increases in this fashion. So, this is an experimentally obtained pressure distribution.

What we need to do is behind the sheet pile, you have to install pressure gauges at the time of construction. You have different types of pressure gauges which are available. You can do stress monitoring. You can do strain monitoring also and how much deflection is being undergone by the system you can measure by using different types of LVDTs here. In the laboratory setups, in the field, you can use the deflection meters, or you can use the theodolite to see how much the wall is deflecting.

So, this is how the complete instrumentation can be done. So, this pressure redistribution is because of the material properties mostly this type of redistribution of pressure is higher in case of the pure frictional material. This is their inherent property not in cohesive soils.

Now, this concept has been utilized to study what is known as bracings or struts. We have discussed about bracings or struts earlier. There is another application of the earth pressure theory for designing the braces or the struts to stabilize deep cuts. So, basically what we want to do is we want to create a deep cut facility in the ground. This is the existing ground surface, and you are installing sheet piles and then removing this material or bringing it up to the dredged level required dredged level.