Geology and Soil Mechanics
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Lecture - 28
In-situ Stresses - C

Welcome back to the course Geology and Soil Mechanics. In the last lecture, we have solved couple of numerical problems on seepage analysis. Today we will be taking another couple of problems.

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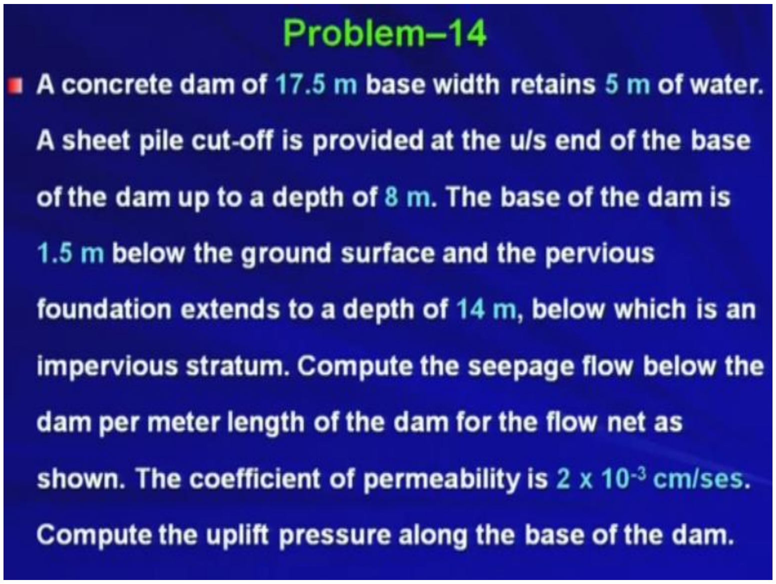

Today's first problem is a concrete dam of 17.5 m base width retains 5 meter of water. A sheet pile cut off is provided at the upstream end of the base of the dam up to a depth of 8 meter. The base of the dam is 1.5 m below the ground surface and the pervious foundation extends to a depth of 14 m below which is an impervious stratum.

Compute the seepage flow below the dam per meter length of the dam for the flow net as shown and the coefficient of permeability is 2 into 10 to the power of minus 3 cm/sec. Compute the uplift pressure along the base of the dam. So, let us see the flow net. How the flow net has been constructed for this dam.

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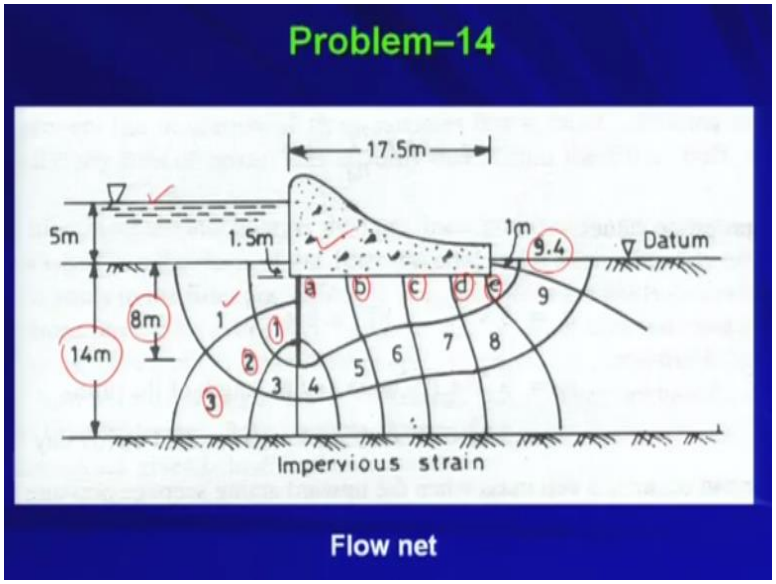

So, in this problem so this is your concrete dam. This is your concrete dam. You have the upstream water surface, water level is here, so which is 5 m above the ground surface and in the downstream you do not have any water level okay. The pervious foundation depth is 14 m okay. The cut off depth is 8 m below the ground surface and the flow net is shown like this. So, you have basically 1, 2, 1, 2, and 3, so 3 number of flow channels okay whereas you have 1, 2, 3, 4, 5, 6, 7, 8, 9, and 9.4 number of potential drops okay.

So, first with this flow net basically you need to calculate the seepage flow across this pervious foundation bed and then you need to find out the uplift pressure at different points point A, B, C, D, and E right. So, these are the points are lying just at the base of the concrete dam and you need to calculate the seepage or rather uplift pressure and you need to draw the uplift pressure distribution along the base of the dam. So, this is the problem. So, let us solve this problem.

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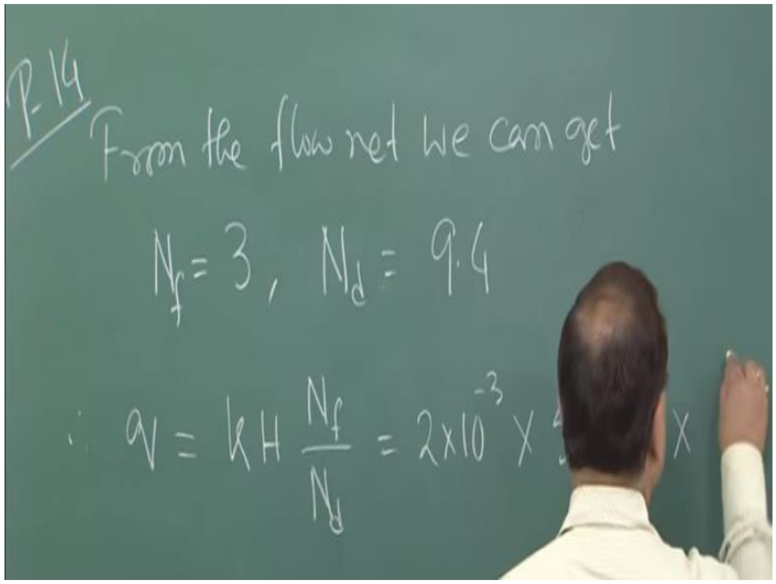

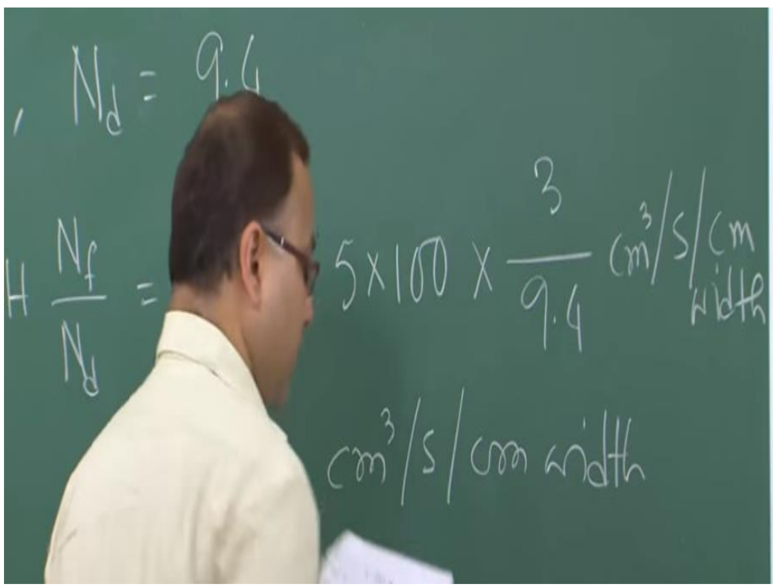

So, problem 14. So, as we have seen from the flow net we can get N f that is number of flow channels. How many number of flow channels are there in the problem? So, if you look at the flow net you will see that N f is 3 and N d that is the number of potential drops is 9.4 right. So, I mean this fraction is coming based on the I mean you are constructing the flow net. So, it is given in the problem that you have 9.4 number of potential drops okay.

So, the seepage flow should be equal to as we know from this 2 into 10 to the power minus 3 into 5 into 100 in centimeter so what is H? H is the head which is causing the seepage flow so that is nothing but 5 in the upstream side minus the level in the downstream side. So, upstream side water level is 5 meter but in the downstream side is completely dry so there is no water level in the down at the downstream stream side so you have H is equal to 5 m. So, 5 into 100 is 500 cm into 3 that is N f then divided by N d that is 9.4.

This is centimeter cube per second per centimeter width of the dam okay so which comes around 33 cm cube/s/cm width of the dam. Now as we have discussed in the lecture that using the flow net basically these are the different advantages of the flow net so if you draw the if you construct the flow net you will be getting several informations right. One is the seepage flow so that just now we have calculated that. Similarly, you can find out the pressure distribution uplift pressure distribution at the base of the any I mean hydraulic structure.

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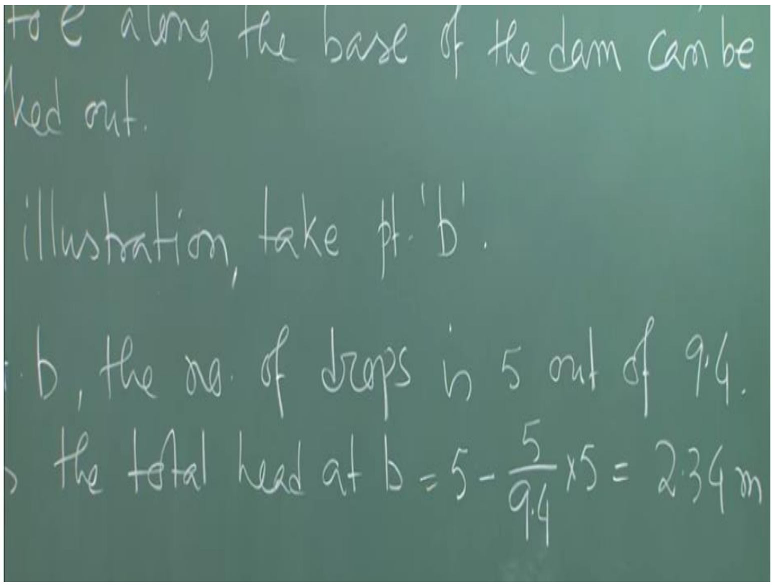

So, now basically using the flow net, the pressure head for points a to e along the base of the dam can be worked out okay. So, for illustration okay so for illustration for illustration purpose we are considering take point say b okay. For illustration purpose, we are considering point b so we will calculate the uplift pressure at point b and then we will follow the same procedure for other points okay. So, at point b the number of drops is how many? So, how many potential drops you are getting at point b? If you look at the flow net once again so basically your point b is coming here right.

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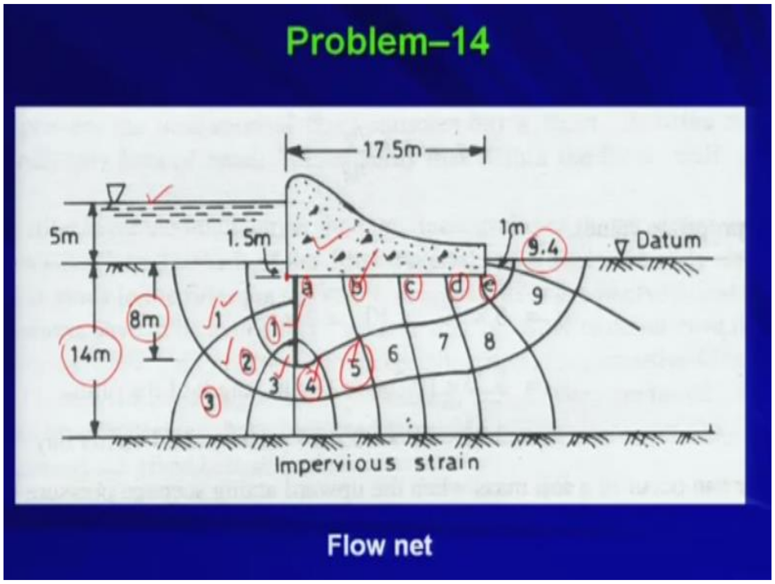

So, this is your point b. So, at that time how many potential drops you are getting, 1, 2, 3, 4, 5 right. So, 5 number of potential drops you are getting at point b. So, is 5 out of total 9.4 right. So, total number of drops is available in the problem is 9.4. So, at point b you are getting number of drops is 5. So, thus the total head at b is equal to 5 minus right. So, 5 is the initial head and this is the 5 divided by 9.4 into 5 is nothing but the delta h right. So, this is the loss is happening if you reach point b. So, that gives me 2.34 m okay.

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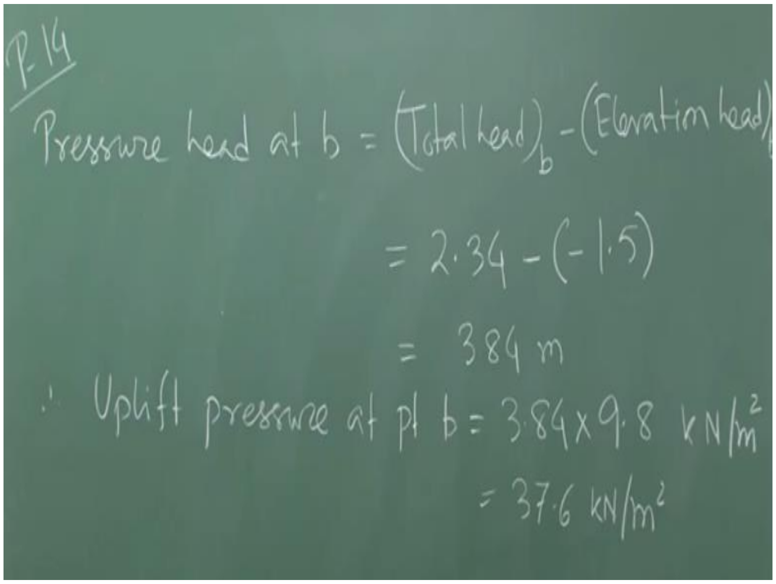

Therefore, pressure head at b is equal to how much? The total head at point b minus the elevation head right at point b, very simple right. The total head minus the elevation head will be giving you the pressure head. That means the total head is equal to pressure head plus elevation plus velocity head. So, those all those heads will be added together to get the total head right. So, you know total head at point b you know elevation head at point b.

So, let us see what is your total head at point b, just now you have calculated right. That is the total head at point b 2.34 - 1.5 m is your elevation head. If you look at the problem once again so b basically the I mean the base of the concrete dam is lying at 1.5 m below the ground level. So, if I consider the ground level is my datum as shown in the problem so the elevation head of the b of point b is minus 1.5. It is as simple as that okay. So, ultimately, I am getting 3.84 m. So, this is my pressure head at point b and which needs to be calculated right.

So, the uplift pressure at point b is therefore equal to 3.84 into gamma w kilo Newton per meter square. So, that gives me 37.6 kilo Newton per meter square right. So, for point b we have calculated the uplift pressure. Similarly, we can calculate the uplift pressure at all the points a, b, c, d, e all the points whatever are shown in the problem and we can get the pressure distribution, uplift pressure distribution curve. So, let us see how we can find out all those things. So, I will not go for detailed calculation. Rather I will put the values. So, we will make a table and in that table, we will give the values of uplift pressure for each and individual point.

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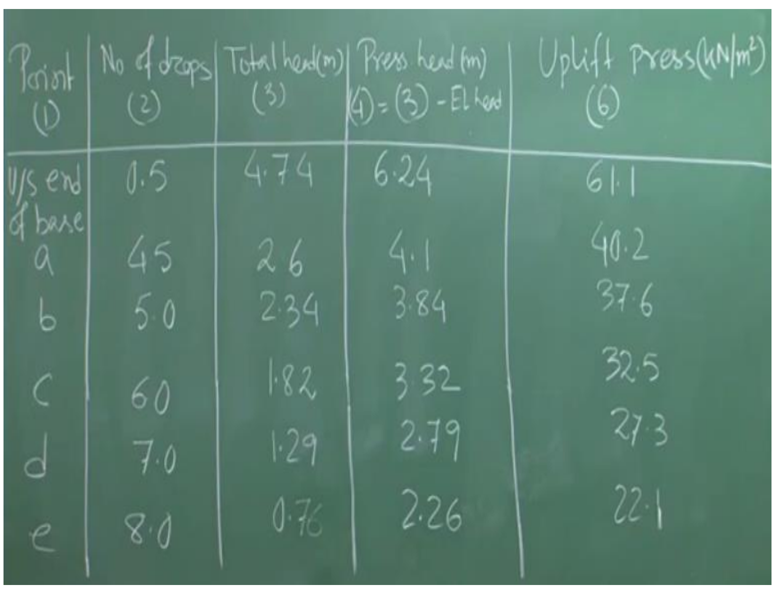

Point (1)	No of drops (2)	Total head(m) (3)	Press. head (m) (4) = (3) - El head	Uplift Press(kN/m^2) (6)
U/S end of base	0.5	4.74	6.24	61.1
a	4.5	2.6	4.1	40.2
b	5.0	2.34	3.84	37.6
c	6.0	1.82	3.32	32.5
d	7.0	1.29	2.79	27.3
e	8.0	0.76	2.26	22.1

Point that is column 1, number of drops that is say column 2, total head in meter that is say column 3, pressure head measured in meter say column 4, which is nothing but column 3 minus elevation head already we have seen when we solved for point b we have seen this thing and then you can calculate uplift pressure that is say column 6. So, that is in kilo Newton per meter square okay. So, basically you can find out the pressure at each and every point starting from a to e okay as well as the corner upstream corner of the dam upstream corner at the base of the dam you can also find out right the pressure.

So, first we will find out upstream end of base that means if you come to the figure the point is lying here right. So, this is the point we are going to find out the uplift pressure okay. So, how many number of drops how many number of drops are there for upstream end of the base? So, approximately that will be the average between first and the second potential lines right. So, it is coming so you if you come at the corner or and end of the base basically you will be having number of drops approximately equal to 0.5.

So, that we can assume. I hope that you have understood that thing. So, the corner or the end of the upstream end of the base basically is lying in between first potential drop line and the second potential drop line so it is the total one number of drop is not available for that point. So, we are taking the average of that so 0.5 number of drop is available for that point that is upstream end of the base.

So, total head at that point can be calculated as 4.74 right. So, the way we have calculated the total head for point b, in a similar fashion we can find out the total head at that point. So, 4.74 right. So, how we will get 4.74? 5 minus 0.5 divided by so 5 - 0.5 divided by 9.4 into 5 so that gives me 4.74 if you look at okay. So, similar way we can find out the total head for this point. Then the pressure head will be 6.24. How I will get 6.24?

The total head minus the elevation head. What is the elevation head for this for this point that is the upstream end of the base, minus 1.5, because all the points are lying at 1.5 m below the datum. So, all the points I mean the I mean elevation head is 1 - 1.5 for all the points along the base of the dam. So, 6.24 and finally your pressure is 61.1 okay. I hope this is clear to you okay. So, now we will be calculating for other points.

So, a, b, c, d, and e okay. So, for a what is the number of drops? So, for point a your number of drops is how many? So, we if you look at point a basically so point a is lying here, somewhere here right. So, at point a or point a rather is coming in between number 4 and number 5 equipotential lines am I right? So, it is coming within 4 and 5 number of equipotential lines. So, the drop could be approximated as 4.5. So, these are the things you have to take your own judgment right okay.

So, 4.5 and the total head is 2.6 that you can calculate and then pressure head will be 4.1 and uplift pressure will be 40.2. Similarly, for b already we have calculated. 5 is the number of drops 2.34 is your total head, 3.84 is your pressure head, and 37.6 your uplift pressure. At point c what is the number of drops? If you look at point c, point c the number of drops is 6 okay. Then 1.82 is your total head and 3.32 is your pressure head and 32.5 is your uplift pressure. Similarly, for point d 7, 1.29, 2.79, 27.3 is your uplift pressure. Similarly, for point e 8 then 0.76 okay that is 0.76 is your total head and then pressure head is 2.26 and this is your 22.1 okay. So, now let us draw the pressure distribution diagram, uplift pressure distribution diagram.

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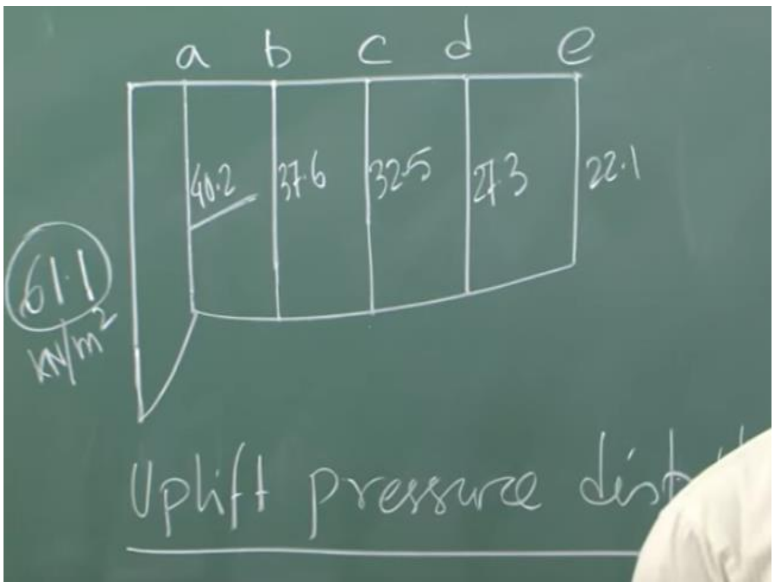

So, this is the point, end of base, then point a, b, c, d, and e okay. So, what is the uplift pressure at the point, at the end of the base, the upstream end of the base. So, this is your uplift pressure that is 61.1 okay. Then at point a what is your uplift pressure, 40.2 okay. Then at point b what is your uplift pressure, 37.6. Then at point c 32.5. So, basically you will be getting the curve like this. So, this is 40.2, 37.6, 32.5 all are in kilo Newton per meter square 27.3 and 22.1 okay.

So, this is your now you see that you had the pressure of 61.1 kilo Newton per meter square uplift pressure just at the end of the base right at the upstream end of the base. Now because you have put some cutoff so you have got some reduction in the pressure, immediate reduction in the pressure which is immediately I mean behind the cutoff point that is cutoff means this is your cut off right this is your cutoff.

So, immediately behind the cutoff the point a is situated and at point a you are getting some reduction in the pressure. So, this cutoff will basically reduce the uplift pressure. So, this is another lesson you have got now this cutoff, why this cutoff is provided. This cutoff will significantly reduce the uplift pressure at the base of the hydraulic structure. So, this is your uplift pressure distribution plot okay. I hope that you have understood the whole problem. So, I will stop here today. So, in the next lecture we will talk about another or we will take another numerical problem in the seepage analysis okay. Thank you very much.