Application of Soil Mechanics
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Lecture - 07

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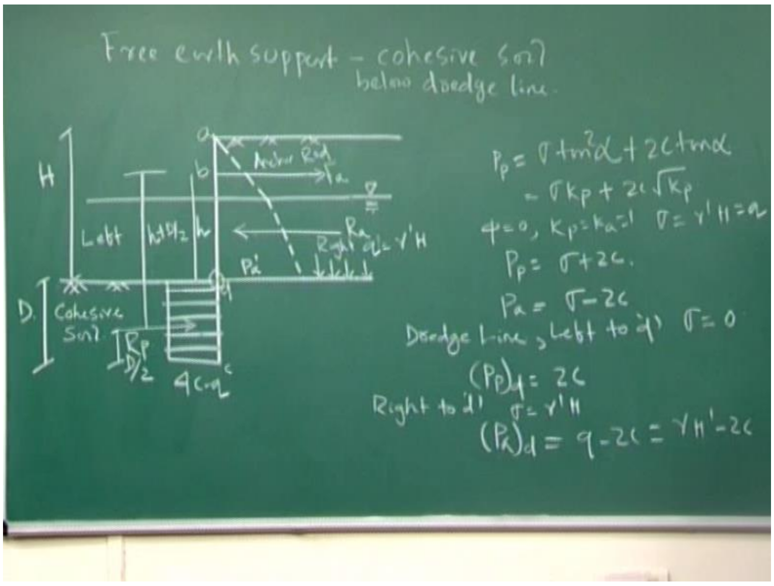

We have already finished about this derivation of anchor bulk edge in granular soil now will see this anchor bulk edge or particularly free earth support free earth support cohesive soil below your dredge line. This is the wall and this side is your soil and this is your anchor rod taking force f a anchor rod now what it say second derivation for free earth support or cohesive soil below the dredge line. If this is my dredge line the condition for this below the dredge line it should be cohesive soil, it does not mean that above the dredge line. It should cohesive soil it may be a cohesive soil, it may be cohesion less soil or it may be c phi soil the condition for this below the dredge line. It should be cohesive soil now as as per earlier case draw the pressure distribution diagram and find it out what is your embedment depth d.

Now take the case for most adverse condition; that means, take water table somewhere else below these and name it. If this is my a anchor rod at position b and this is your c and dredge line this is your d now four c minus q and this is your r p and d if I take this distance is d and this will be your d by two d by two.

Let us consider this part is your cohesion less soil you can consider also cohesive soil accordingly the pressure distribution will change p a prime as usual this is your this is your result and force r a. And now this is your search as over this has been considered. Let us say this is your q prime q which is equal to gamma prime h. Now if I take these distance is your h capital h now the distance from here two anchor rod two anchor rod this will be small h plus d by two now from anchor rod to here the distance.

Let us assume this is your h means what is the condition for free earth support means equilibrium condition will satisfy, and this r the point of anchor rod the movements should be zero as we have explained earlier at the point of anchor rod. The movements would be zero; that means, with respect to anchor rod you find it out the distance of your resultant force R a, and resultant force R p. So, once you get the distance then you can take movement at point b bigger b point is your anchor rod position then you can find it out the embedded depth d.

Now as I said also earlier in case of sit by wall or sit by walls what is your va value of p p passive earth pressure it is your sigma time square alpha plus two c time alpha this is for cohesive soil. So, it is your sigma k p plus two c root over of k p now for phi is equal to zero phi is equal to zero k p is equal to k a which is equal to one and sigma is equal to gamma prime h which is equal to q. So, now, p p is equal to sigma plus two c. Now p a similarly similarly p a is equal to sigma minus two c; that means, I try to derive from this general equation of p p and p a, it is in terms of sigma time square alpha plus two c time alpha.

And this is your p p from that condition is if it is a purely cohesive soil; that means, phi is equal to zero once phi is equal to zero k p is equal k a is equal to one how come which is equal to one minus sin five by one plus sin five. So, which is equal to your value will be one and sigma is equal to gamma prime h which is equal to q now from there passive earth pressure is coming out to be sigma plus two c passive earth pressure active earth pressure is coming out to be sigma minus two c.

So, let us consider the dredge line consider your dredge line this is my dredge line in this dredge line at the left hand side if I put it both the where left and right let me start with these I am standing here. So, I am looking at here the wall best on that this has been consider a right this has been consider left side let us consider this is your left and this is your right. So, in the dredge line left side left to point d left this i, my point d left to point d what will happen where is your over button pressure left to point d there is no soil there is no soil; that means, this over button pressure will be zero; that means, sigma is equal to zero. So, in that case sigma is equal to zero meansm if I write p p into d how much it will becoming it will becoming only two c.

Now similarly at the dredge line point d to your right right to d right to point d right to point d means there will be searches because these are all filling by soil. So, right to point d sigma is equal to gamma prime h. So, it will be your what is your active air pressure P a d p a d is equal to q minus two c and which is equal to gamma h prime minus two c. This is again because of the assumption the assumption for these case is there for particularly free earth support if you remember last to last class for free earth support the assumption is movement anchor rod is zero then another part is your phase of the wall it will be acted by active and back will be passive. So, this side will your passive this side will your passive active. So, from their right to d i put is as a active earth pressure left to d left to d is your this position i put as a passive earth pressure, it is coming two c, it is coming q minus two c net pressure will be net pressure at point d.

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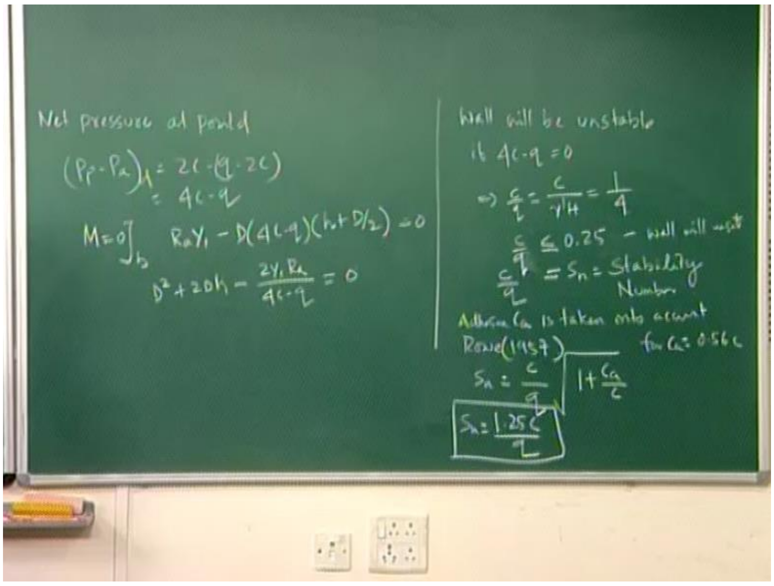

Which is equal to passive minus active at point d which is equal to two c minus q minus two c which is equal to four c minus q. Now you got how this four c minus q term has come. Now we can get it, this has been derived, this is your passive earth pressure minus active earth pressure. This is coming four c minus q let us consider the result and of this pressure is R p, and here result and of these pressure is your R a. Now considering movement is equal to zero m is equal to zero at point b. At point b, so they take movement and find it out how much is your movement from their you can get derivation of d then with your r a from here to here distance this is your y one sometimes you can write y bar or y two as per the naming you can give it. So, movement is equal to zero then r a y one minus d four c minus q d into four c minus q if you look at the base is four c minus q d is your height.

So, this is a area and into distance distance is small h plus d by two d by two is equal to zero from there you can get it d square plus two d h minus two y one r a by four c minus q is equal to zero. So, d may be increased by twenty to forty percent as i said earlier this is your minimum requirement of d. So, may be increased you can add additional say twenty to forty percent. So, that it will be safe now another condition is there the wall will be unstable the wall will be unstable wall will be unstable if four c minus q is equal to zero; that means, the pressure are the base.

Are the site of this left hand side if it zero then wall will be unstable because one side this pressure there other side there is no pressure. So, based on that based on that it will be coming c by q is equal to c by gamma prime h which is equal to one by four or you can say that c by q less than equal to zero point two five if c by q look at this equation. If c by q what is c c is your cohesion and q q is your; that means, q is equal to q is equal to gamma prime h c is equal to cohesion. If whatever the search or the other in and what is the c cohesive soil if it is less than zero point two five; that means, this is onset wall will onset.

So, c by q generally we termed as c by q you termed as s n which is you call stability stability number. Now there are certain correlations even certain relations if has been given if c i is taken into account adhesion factor if adhesion c a is taken into account taken into account the according to raw nineteen fifty seven. So, stability number s n is equal to c by q root over of one plus c a by c one plus c a by c. So, for c a for c a is equal to zero point five six c. So, stability number s n is equal to one point two five c by q s n is equal to one point two five c by q. So, there are two two terminology if you are taking into consideration of adhesion c a then stability number is your approximately one point two five c by q.

If this is your stability number then it will be stable again if you are not considering your adhesion factor then stability number is equal to c by q and it is would not be less than equal to zero point two five it is would be greater than zero point two five. So, that this will be stable; that means, minimum c by q minimum part of the pressure c by q required is your greater than zero point two five otherwise it is not going to be set or it will be completely onset.

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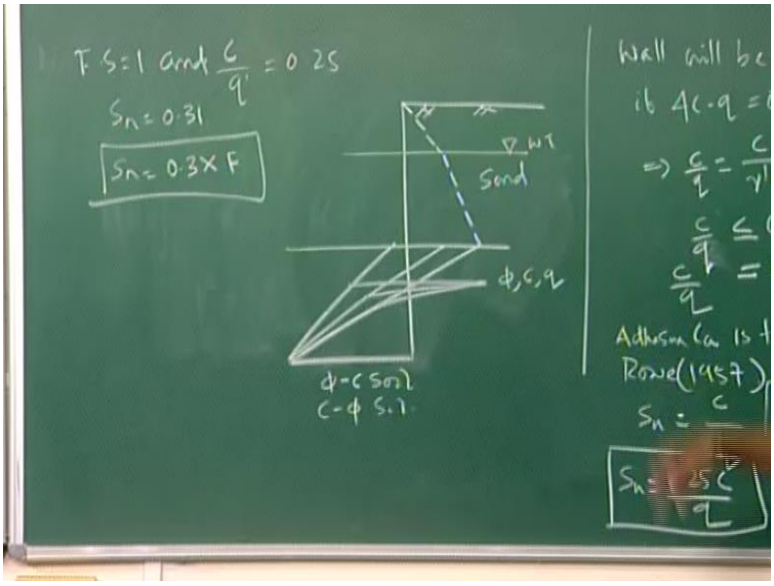

Now, will solve a problem or you can see some of the some of the another graphical form I can show it for a factor of safety say one and c by q prime is equal to zero point two five the stability number s n zero point three one with wall adhesion. So, s n is equal to you can say that s n is equal to zero point three into factor of safety in a seat phi design clay the walls would have stability number s n is equal to zero point three into factor of safety f is nothing, but your factor of safety. So, if draw this if you look at here, let us draw the graphical form.

It all depends upon the pressure distribution diagram depends upon phi c and q phi c and q if you look at here phi c and q. Then what will happen this is particularly this case will be sand back field sand back field, this is your clay cohesive phi phi c soil or c phi soil you can say that c phi soil. If you look at here how this stabilities vary. If this stability number if this is not going to satisfy; that means, the pressure distribution diagrams slowly slowly it is varying it is coming towards your tension. So, it all depends upon phi c and q c and phi is your parameter basic string parameter and q is nothing but how much is your search charge; that means, you need to wait into height. What is your surcharge as is your q, these all depends upon your c phi and q this is a typical case where this is a c phi soil below the dredge line above the dredge line it is sand. Now will solve a problem example problem and will see if I remove all right the basic equation, what is the basic equation for these condition.

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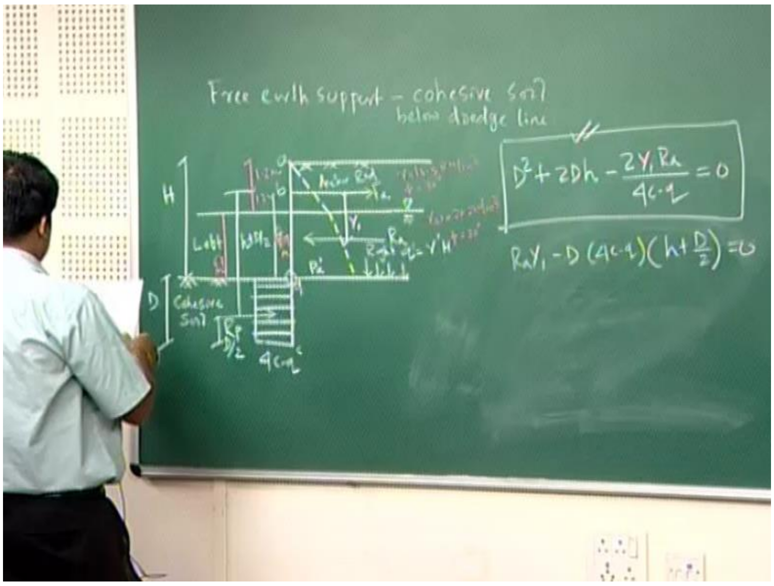

Whatever you have derive for d the basic equation is d square plus two d h minus two y one r a by four c minus q which is equal to zero and this has come from r a y one minus d four c minus q into h plus d y two is equal to zero; that means, movement at anchor rod is equal to zero from they are it is in terms of second order equation d square plus two d h mi minus two y one r a by four c minus q. Now will solve a problem example problem. What is this example problem what are the parameters given. If you look at the example problem, this height is given, this height is given, particularly this is your one point zero meter. Then this is again one point two meter and these part completely this is your from here to here it is your six point seven six point seven meter then h is equal to from here to here six point seven plus one point two which is equal to seven point nine meter seven point nine meter.

Now here gamma is equal to sixteen point five kilo newton per meter, q phi is equal to thirty degree and below the water table gamma saturated is equal to twenty point two kilo newton per meter q and value of phi is equal to thirty degree. Now if you look at here above the dredge line this is a cohesion less soil and below these this is a cohesive soil now for cohesive soil c value how much is your c value is given c is equal to seventy two point two c is equal to seventy two point two. This is your example problem a c a anchor rod or c i means bulk anchor bulk edge has to be embedded in a cohesive soil where c is equal to seventy two point two kilo newton per meter square.

Above this the anchor rod is provided below one point two meter and water table is located at two point four meter, and the properties has been given gamma is equal to sixteen point five phi is equal to thirty degree. And below the water table gamma saturated is equal to twenty point two kilo newton per meter q phi is equal to thirty degree; that means, this is a cohesion less soil, and other parameter has been given the value of h is six point seven plus two point four. So, it will be nine point one nine point one total height above the dredge line. Now, has draw the pressure distribution diagram, if I draw this part of the pressure distribution diagram, this is the pressure distribution diagram.

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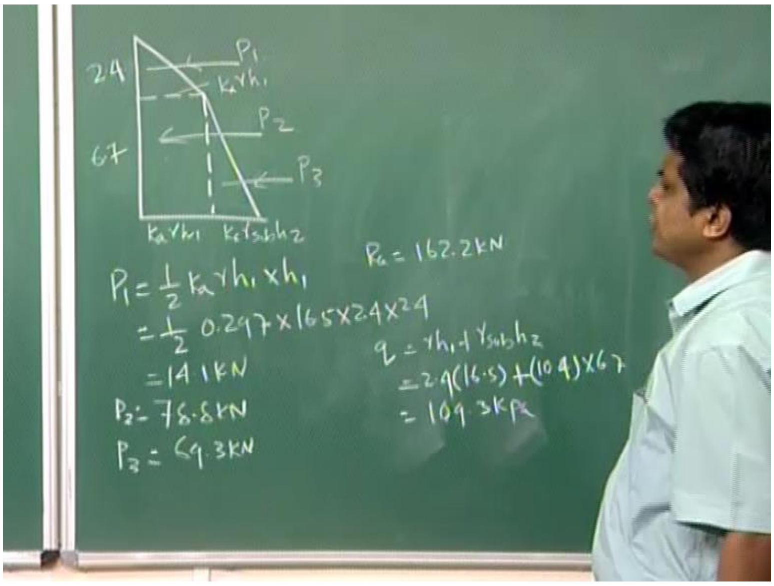

If I make it very clean for calculation this is your two point four this is your six point seven and let us take part by part. As I said earlier say p one say this is p two say this is p three. So, this will be k a gamma h one and this will be your k a gamma submerged h two k a gamma h one. Now, here also it is given delta is equal to delta is equal to twenty degree it is also given; that means, friction between wall and soil delta is equal to twenty degree upper part it is given. So, based on delta and phi based on delta and phi k a is equal to k a dash which is equal to zero point two nine seven and k p is equal to k p dash which is equal to zero point ine it has been calculated. So, if you take from your dredge line above the dredge line the pressure distribution diagram whatever it is there i put here it is for your cohesion less soil. So, not to do mistake it has been divided into number of parts, so one, two, three. So, I put it p one p two and p three.

Now you can calculated, what is the value of p one p two and p three; if I calculate; one calculation I am showing, rest calculation you can do yourself. So, p one is equal to half k a gamma h one into h one which is equal to half zero point two nine seven into sixteen point five into two point four into two point four which is equal to fourteen point one kilo newton. So, one calculation I am showing p one. Now we can calculate p two value similarly which is equal to seventy eight point eight kilo newton now p three is equal to sixty nine point three kilo newton then r a is equal to r a is equal to hundred sixty two point two kilo newton.

Then q is equal to q is nothing, but your search as search as is equal to you can calculate this calculation I am showing gamma one h one plus gamma submerge h two. If you look at water table is lying here below the water table it is taken gamma submerge above the water table it is gamma. So, gamma one h one means these height gamma gamma into this height this height is one point two plus one point two this is a two point four and gamma submerge it is d your saturated unit which is given twenty point two. So, gamma submerge is equal to twenty point two minus nine point eight this is your gamma submerge and gamma submerge into height is given this height is given how much six point seven.

So, based on that q has been calculated which is equal to as i say two point four h one is your two point four into sixteen point five sixteen point five is your gamma plus gamma submerge gamma submerge is equal to let us say ten. So, twenty point two minus ten, it is your ten point four or nine point eight, it has been say it has been taken nine point eight, so ten point four into six point seven. So, it is coming one zero nine point three k p a one zero nine point three k p a. So, once you get p one p o two r a q this is your upper part now find it out with your once you get r a you can find it out what is the distance from your anchor rod as you have a solving earlier you can find it out y one. So, y one supposed to come four point six seven meter below anchor rod below anchor rod.

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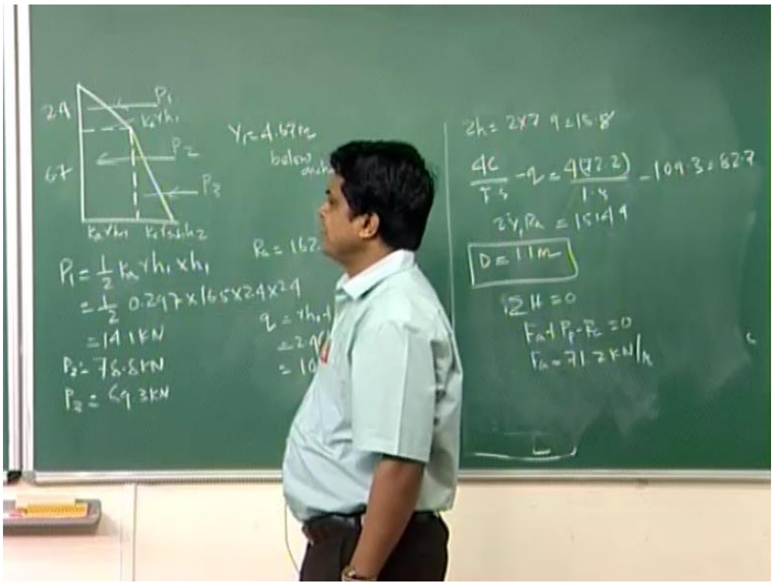

Now if I put it, what is a value of two h, h is equal to two into seven point nine which is equal to fifteen point fifteen point five fifteen point eight fifteen point eight. Now four c minus factor of safety minus q as I said the c value is in the question c value even seventy two point two. And it has been said not to as i said earlier not to use factor of safety it has been said take factor of safety in the cohesion for stability and others take factor of safety in the cohesion. So, factor of safety is given one point five. So, in the question factor of safety has been given one point five. That is why it is four c by factor of safety minus q i got it for into seventy two point two by one point five minus one zero nine point three, which is equal to eighty two point seven then two y bar r a two y bar r a y one r a. So, it will be coming in e five one four point nine.

If you look at this equation, I want to put it here one is two h down other is your two y one r a when four c minus q. If I put all then if I solve it the d comes out to be d comes out to be one point one meter d comes out to be one point one meter. Now once you get the d find it out force f a find it out force f a. So, force f a will be. If I take summation of horizontal four c h is equal to zero it will be your f a plus p p minus r a which is equal to zero. So, f a is equal to seventy one point two kilo newton per meter.

Now check whether this is working or not working, whatever you have derived whether it is fine or not. Then what will happen in that case, take the movement about anchor rod, because these value is there, this thing is there, take the movement about the anchor rod. You have your anchor force also you have these take d take the movement it is would come approximately zero it will not come exactly zero. It will come something about zero point zero something or zero point zero something zero point zero one zero point zero zero one may be sometimes zero point one then this calculation is ok.

So, in this case, what will happen as we have taken factor of safety in c. In c, during the calculation, no need to extend your embedded depth, if these factor of safety has not been taken here then you have increase your embedded depth twenty to forty percent that is all. We will see next class.

Thanks a lot.