Foundation Design
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Lecture - 9B
Stress Distribution in Solis-Part 1

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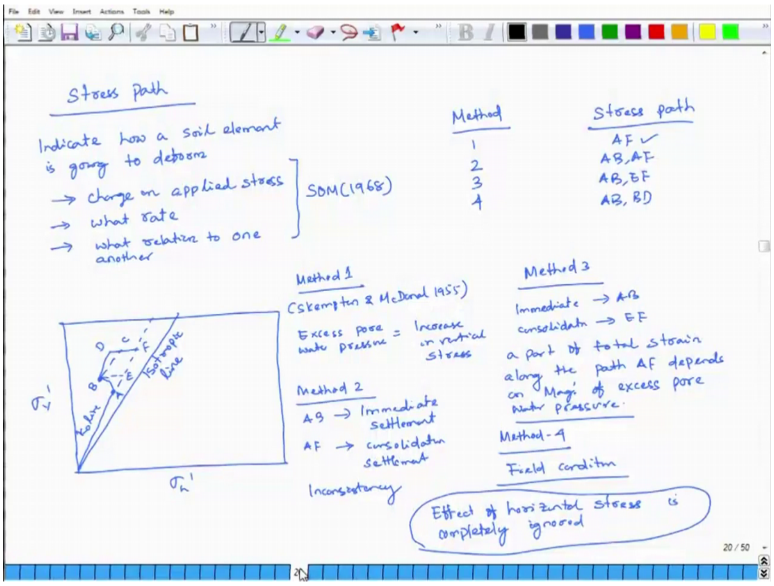

So till now, we have finished settlements. So, I have covered settlement calculations per sand as well as clay immediate as well as consolidation settlement and last class I have covered also by means of stress path method how do calculate consolidation settlement.

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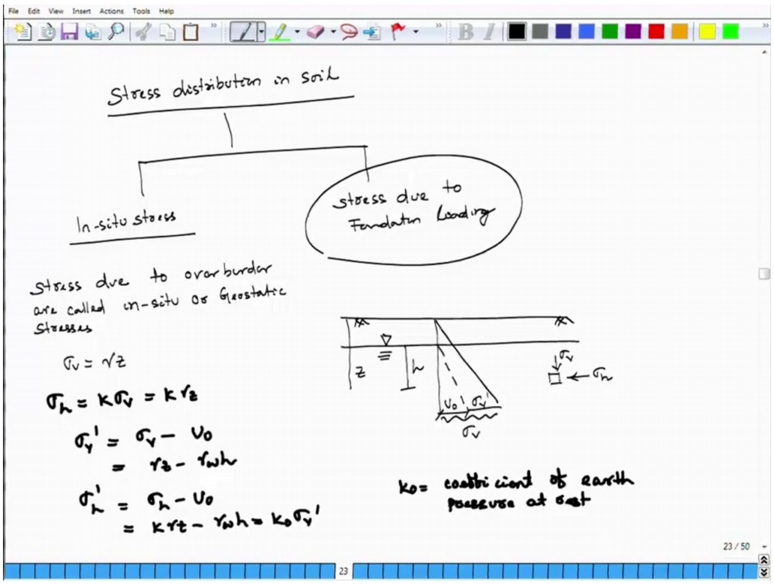

Now we can start a new that is your stress distribution in soil stress distribution in soil. So, basically if I put it stress distribution in soil I can put it in 2 parts one is your in situ stress second is yours stress due to foundation loading stress due to foundation loading.

So, primarily this is important for all of us design foundations because depending upon your size of the foundations how much is your increasing stress in a soil mass. Now if you come back to in situ stress in in-situ stress is due to a means stress due to over burden are called in situ or geostatic stress due to over burden are called in situ or geostatic stresses. So, take an example here the layer of soil and here is your water table then there is a soil element here and this is your sigma v and this is your sigma h and then altered depth z below water table this is your h then come the ground surface it is altered depth z.

So, here if you look at here this will be your sigma v and this part of here will be u 0 and this will be your sigma v prime. So, vertical stress sigma v is equal to gamma z and then total horizontal stress sigma h is equal to k sigma v which is equal to k gamma z. So, sigma v prime which is equal to sigma v minus u 0 which is equal to gamma z minus gamma w in to h and sigma h prime h prime is equal to sigma h minus u 0 which is equal to k gamma z minus gamma w in to h which is equal to k 0 sigma v prime k 0 is your coefficient of earth pressure k 0 is equal to coefficient of earth pressure at rest. So, this is about is your stress; that means, in situ stresses.

Now, come to stress due to your foundation loading stress due to your foundation loading.

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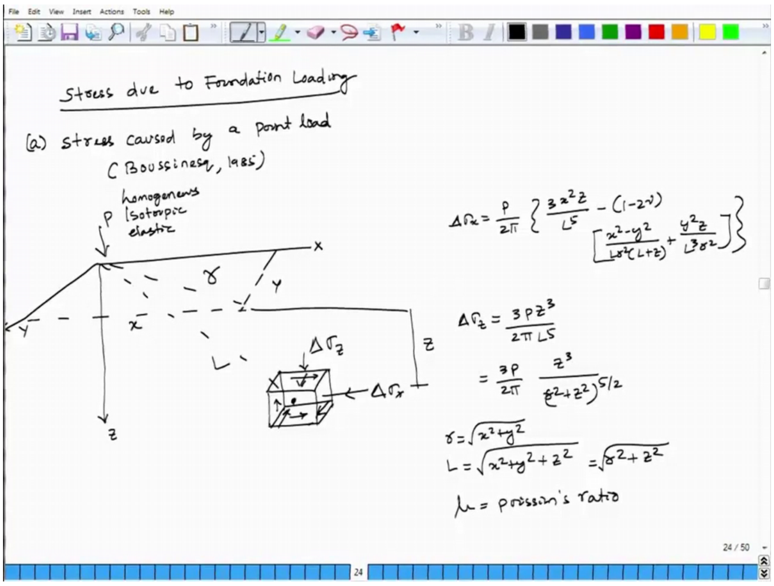

Now, there are many cases stress due to your foundation loading if I say what type of loading comes in to the foundations it may be a point load it may be a circular loading generally foundations are constructed on isolated footings strip footings combine to footings graph foundations as well as a rectangular foundations. So, it may be a rectangular loaded sometimes it may be line load or foundation of any shape any shape. So, what will happens is due to foundation loading start we trace stress caused by a point load this is called Boussinesq theory; Boussinesq 1985 up tend a solution for stress and determine the interior of soil mass due to vertical point load applied at the ground surface take an example this has been given by Boussinesq b o u s s i n e s Q 1985.

So, if I draw it a 3 dimensional figure here this is your z direction this is your x directions and this part is your y directions now consider in elements soil element here it is like this then 3 d element here you can show it if you take a point here then you can show it this way this way this way and here you are showing this way this way and this will be your delta; delta sigma z. Similarly, here it is coming delta sigma x. So, it will have this way then if I consider this will be my distance of from this point to this point this will be x and this part will be your y and this is your x sorry this is your x and this distance from here to here is your r and from here to particularly here ground surface to at the middle this will be your z the detailed derivation is out of scope because this is an under graduate course.

So, what are the assumptions Boussinesq has taken solid homogeneous isotropic then elastic now they derived it increase in stress; that means, lateral stress as well as vertical stress as well as y. So, delta sigma x which is equal to p by 2 pi 3 x square z by l fifth minus 1 minus to nu into x square minus y square divided by l r square into l plus z plus y square z by l cube r square.

So, similarly they have also derived for delta y 3 dimensional delta sigma z vertical stress increase in vertical stress which is your 3 p z cube by 2 pi l to the power by 5 which is equal to 3 p by 2 pi z cube by r square plus z square to the power 5 by 2 or r is equal to x square plus y square root over and l is equal to this is your l distance from here to here l is equal to x square plus y square plus z square root over which is equal to r square plus z square root over mu is equal to z Poisson's ratio.

So, Boussinesqs has given suppose there is a point load here I forget here; suppose there is a point load p at the ground surface because of this point load what will happen stress below the point load as well as (Refer Time: 11:54) by at a distance x or at a distance r or at a distance l below the ground surface what is your stress variations because of your point loading. So, then come to its physical part I will discuss one by one.

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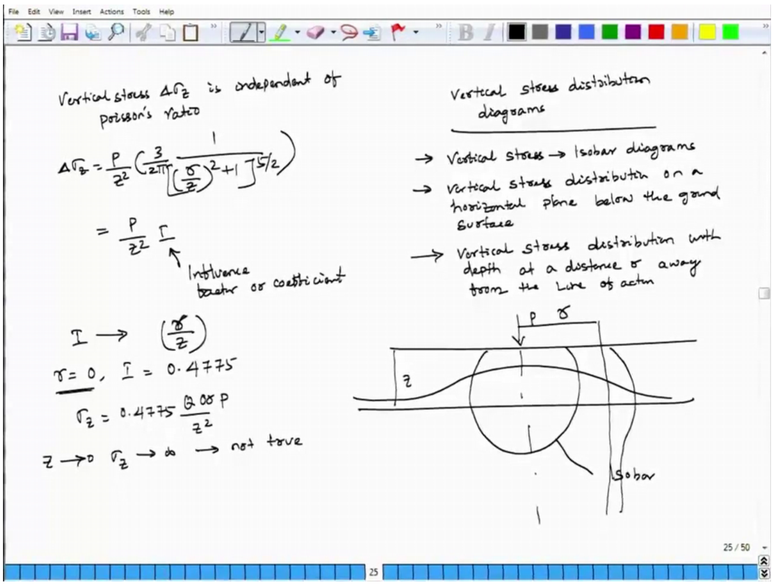

So, vertical stress I can write it vertical stress delta sigma z delta sigma z is independent of Poisson’s ratio; Poisson’s ratio. So, if I can write it delta sigma z is equal to p by z square into 3 by 2 pi 1 by r by z whole square plus 1 to the by 5 by 2 which is equal to p by z square in to I is nothing but is your influence factor or influence coefficient I is nothing but is your z influence factor or coefficient influence factor or coefficient. So, there are charts given there are charts given variation of I for various value of gamma z in any text book you can find it out variation of I different value of I variation of I for various value of r by z r is your distance and z is your vertical distance.

So, when r is equal to 0; that means, when r is equal to 0 at that point I influence factor is equal to 0.4775; 0.4775 vertical stress directly below the foundation load just directly below the point load then it is your r is equal to 0 means if you come back here r is equal to 0 this r is equal to 0. That means vertical stress below the point load just at this point. So, then it will be I is equal to 0.447; 0.4775 then in that case sigma z is equal to 0.4775 Q by z square or Q instead of writing Q you can write it Q are maybe it is a p p by z square.

Now, come to next part z tends to 0; that means, depth tends to 0 what will happen z is equal to 0 z is equal to 0 means this depth is equal to 0 r is equal to 0 fine next step is a z is equal to 0 once z is equal to 0 what will happen it will be infinity sigma z tends to infinity which is not true there will be some value at z is equal to 0 it is not going to tends 0 theoretically as it says it is not tends to 0. So, this is part of this your point load then giving this value of your re distance r you can find it out what is your delta sigma z as sigma z because your point load then r is equal to 0 the I is equal to 0.4775 sigma z is equal to 0.775 Q or p this is not Q by p this will be let me write it because here I have written p noting Q or p by z square.

Now, come to next part vertical stress distribution diagrams first one is your vertical stress isobar diagrams second one is your vertical stress distribution on a horizontal plane below a ground surface vertical stress distribution on a horizontal plane below the ground surface. Third one is your vertical stress distribution with depth at a distance are away from the line of action vertical stress distribution with depth at a distance r away from the line of action away from the line of action.

So, if I draw it here what your suppose to get it this is your point load p I am getting a vertical stress. That means, isobar diagrams this is my isobar this is stress one second one is your vertical stress distribution on a horizontal plane this is my horizontal plane at a distance of z how it varies. And third one is your vertical stress distribution below the ground surface at a distance r from the point load below the ground surface how it varies.

So, these are the 3 cases one is your vertical stress or isobar diagrams second is your vertical stress distribution on a horizontal plane below the ground surface third one is your vertical stress distribution with depth at a distance r away from the line of the action.

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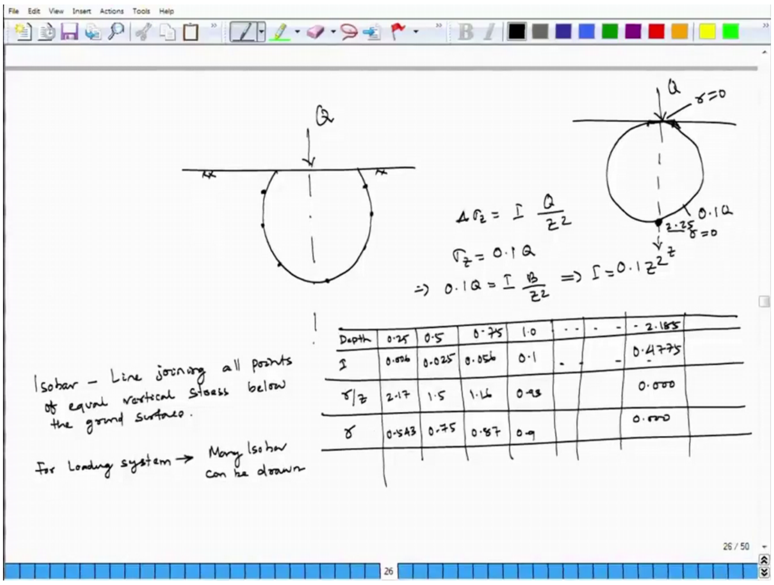

Now what is isobar very simple question what is isobar if this is my ground surface there is a point load here suppose at p or may be Q then this is your central line along the line of your point load and this will be my isobar what is the definition of the isobar if I write it isobar it is the line joining all points of equal vertical stress below the ground surface I am just writing it down line joining all points of equal vertical stress below the ground surface.

So, line joining all points of equal vertical stress below the ground surface whatever it mean isobar. So, it is called isobar also it is called pressure bulk; that means, the point here, here, here, here, here, here, here, these are all equal vertical stresses below the ground surface. Now for a loading system for a loading system for a particular loading system you have for a loading system you have many for a loading system many isobar many isobar can be drawn. So, isobar is called as pressure bulk; it is like a kind of onion shape pressure bulk.

Now, if I go to the second part of this first part is your isobar definition has been made if I go to the same point if I am discussing here isobar diagrams equal points let us say delta sigma z is equal to I into Q by z square here it is a Q let us put it as a not p let us put it as a Q it is your Q by z square. So, assume sigma z equal to 0.1 Q. That means, 0.1 Q is equal to I into b by z square whereas, I is equal to 0.1 z square now consider this; this is your depth this is your I b or I this is your r by z this is your r.

So, depth put it 0.25, I am just calculating very few you can calculated you can see the books then this is your 0.5 and this is your 0.75 and this is your 1.0. So, it is coming out to be 0.006 and this is your 2.17, this is 0.543 and 0.5 is your 0.025 and this is your 1.5 and this part is your 0.75 and this will be your 0.056 and this will be your 1.16 and this will be your 0.87. Now this will be 0.1; 0.93 and this will be your 0.93 if I go up to 2 point like this if I continue let us say if I go up to 2.185. So, here will be 0.4775 and here will be 0.000; 0.000. Now draw it for particular case you draw it and drawing it look at here this is my point load which is your 0.1 Q and this is what I am getting a pressure bulk sorry this is your Q and this is your 0.1 Q pressure intensity and at this point r is equal to 0 t at this point also r is equal to 0.

So, this will be this will be your z this part will be your z. So, this distance will be somewhere else 2.25, now you can find it out infinity value as I said you can assume it sigma z is equal to 0.1 q. So, r is equal to 0 r by z is equal to 0 here at this surface it should be 0.4775 it is not suppose to be 0 it will start from here it will start from here. So, that this part will be 0.4775 then all other values will be 0. Similarly you can plot similarly you can plot for different pressure intensity here it is 0.1 Q you can plot; plot it 0 point 2 Q 0 point 3 Q 0.5 Q all you can plot it this is what is your about your isobar.

So, I will start next class vertical stress distribution on a horizontal plane I will stop it here because this is a long this will be continue in a long.

Thank you.