Geotechnical Measurements and Explorations

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Lecture No. # 06

Analysis of Converter Circuit

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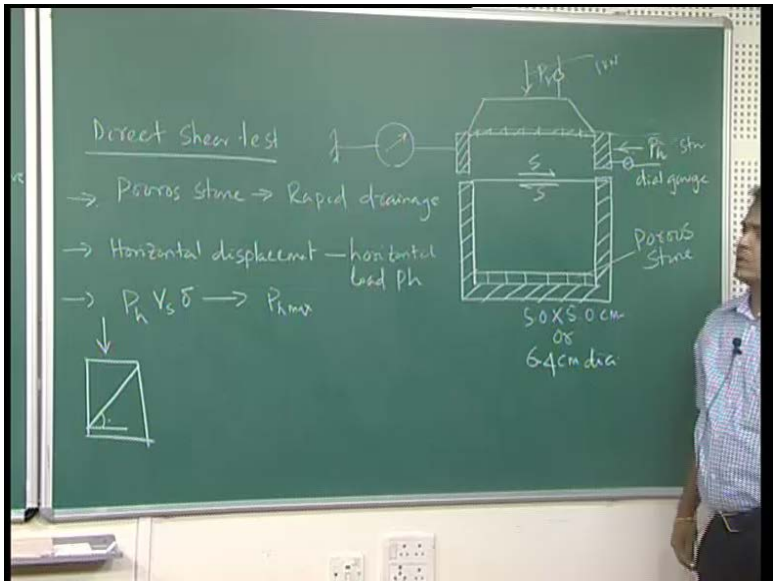

Next part of your, that is direct shear test ((no audio 00:27 to 00:45)). Diagram for direct shear test, I am just drawing ((no audio 00:50 to 05:28)). Next test is your direct shear test. So, direct shear test is (( )) size is either 5 by 5 centimeter by 5 centimeter or 6.4 centimeter dia. It may be a circular shape or it may be a square section. If you will look at, this direct shear test cross sectional view. So, this is a shear box.

With this shear box, bottom is, it is a porous stone, this part is fixed. Then upper part, it can be moved by means of application of lateral load. So, in this case, what happen, this soil filled it off, then half of the part will be also filled by the soil. The box is connected means, this box can be separated into two parts. With this, here lateral load or horizontal load applied by means of applying a proving ring here, and either you apply a proving ring here, or you can apply direct load here, by constant rate measure or may be, you can

apply by strain here, or you can measure load by means of proving ring in the opposite end.

Then, for each vertical load, the concept is direct shear test, the concept is suppose this is a soil sample, it acted upon by a vertical load. So, with this acted upon this vertical load, how this here formation is there. That means, this is your formation of your failure surface. The failure surface in direct shear test, it will be acted upon by vertical load, suppose say, 1 kilo newton or may be 2 k g, may be 3 k g. So, this by area, it is your vertical stress means, that is your normal stress you are applying, and this is your shear stress from lateral load, once the moment you apply the lateral load, soil will be shear. That means, soil will be shear here. Because, this part is moving and this is constant. With this part as it moves, soil itself will shear. Once it will move, the resistance offered by soil by means of this shear, it will be recorded.

So, this proving ring will give this how much your lateral load is coming. That means, you apply here you apply your load, so displacement you are applying, then horizontal load you are applying the p h. So, you record p h versus delta. p h means lateral load versus, how much is your displacement. This displacement can be measured by means of these are the dial gauges.

So, you measure p h versus delta, from where this maximum p h or lateral load, you can get it, for particularly normal load you will get it maximum lateral load. That, you can get it, it will go increase increase increase. Once there is a failure, what will happen, it will decrease. How do you know that it fails, soil fails by means of a shear.

The moment lateral load has been applied one end. So, this soil try to resist. So, it will resist means, this load here proving ring this load will increase. So, from here it will increase increase increase, the moment soil fails by means of shear. What will happen, all of sudden, it will start decreasing.

That means, suppose from zero, initial it is zero, it will increase to 0 5 10 15 division. Then once the failure occur, this will start decreasing. That means, at that point, you stop applying your lateral load. Then, what are the conditions, how do get it. So, for each normal load or normal stress, normal load how do you get it p v.

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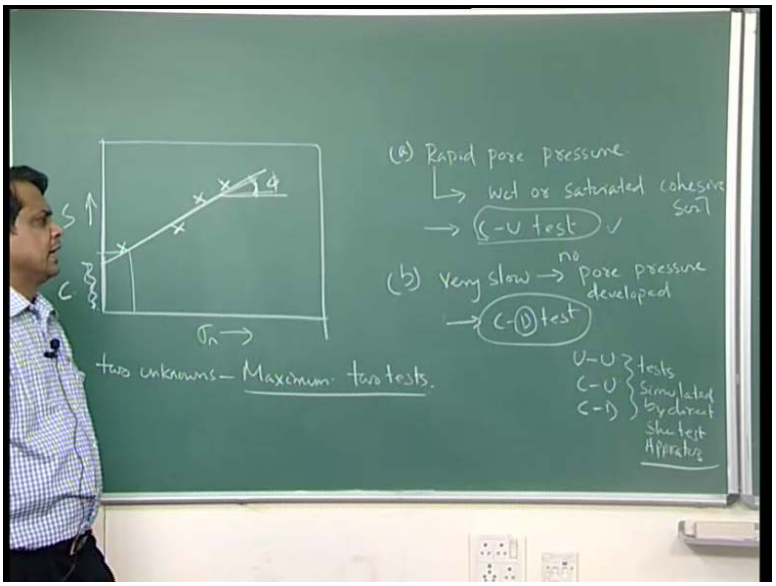

From p v, vertical load above, p v means vertical load and distorted area, if the load by area that is your normal load, you are getting. For each set you are getting, one normal load and one shear stress. Means shear stress, you will get it is, you load you know it, with that area we will get your shear stress. That means, suppose 1 kilonewton normal load, you will find it out, one lateral load.

From there, you plot set of means, there are two unknowns. One is c, other is your phi. Atleast, two tests required for this, two means for this graph to be plotted. So, for a particular normal load, you will get once your load or may be lateral load, that then you find it out normal stress and shear stress. Then you plot the graph d intercept with your shear stress axis, this is your called c. You need question, and the angle it makes with your normal stress angle, normal stress axis, this is your phi. From there, you will get c and phi.

So, next question is, can this is a direct shear test? Can it be possible to conduct consolidated un-drained test, or simulate consolidated un-drained test, by means of direct shear test apparatus, or consolidated drained test?

So, suppose for example, wet and saturated cohesive soil. In case of wet and saturated cohesive soil, what will happen. In wet and saturated cohesive soil, consolidated un-drained, that means, you this is the soil sample, before applying this here, apply your normal load. So, what will happen, it will be consolidated. Then, once consolidation is

over, then shearing rapid by means of this lateral load, constant rate of displacement generally applied. So, constant rate of there is a motor here, so it will give constant rate of displacement. That means, so say 2 m m per second or 3 m m per second. That means, this revolution will be 2 millimeter per second. This motor will go 2 millimeter per second.

That means, if you apply a very rapid displacement rate, what will happen? During un-drained condition, there is un-drained condition rapid pour water pressure will develop. So, this will simulate consolidated un-drained test. In case of, if I say, the soil, I can I simulate consolidated drained test, by means of direct shear test, question is yes. I can do consolidated drained test. So, after doing the consolidation test, because these are the porous stone, after the moment you apply normal load, what happen the consolidation process starts.

After doing consolidated drained means, consolidation. For these consolidated drain test, after doing this means, after this consolidation is over, what will happen. The rate of displacement you apply, very slow rate. Slow rate means, suppose say, 1 m m per second. That means 1 second, the displacement will be only 1 m m, it is so slow, what will happen. The development of pore water pressure will be very less, or it is a case of no pore pressure development. So, that will simulate consolidated drained test. That means, the drainage will be there, so no pore water pressure will developed.

Consolidated un-drained means, consolidation applied, consolidation process will start by applying normal load. Then, after consolidation process is over, you apply lateral load, by means of a high rate of displacement per second, set 2 m m per second, 3 m m per second, or 4 m m per second or 5 m m per second. That means, the revolution on the displacement achieved by the motor for per second, suppose slow rate, it will be only 1 m m. That means, for high rate, it will say, 5 m m.

With this rate of displacement high means, all of sudden it will not get to be drained, after the consolidation is over, all of sudden the pore water pressure will develop. So, you can simulate unconsolidated un-drained test by means of direct shear test, consolidated un-drained test by means of direct shear test and consolidated drained test by means of direct shear test.

Three conditions can be simulated, three triaxial test conditions. One is your U-U, other is your C-U, other is your C-D. These three tests can be simulated by your direct shear test apparatus.

What is the disadvantages of direct shear test? Rather than, because there are three tests required to find it out c phi. One is your quick test, that we explain last class. Then, next is your direct shear test, then third part is your triaxial test.

If I compare with direct shear test with a triaxial test, what is the (( )), what is the drawback in direct shear test. In direct shear test, what will happen. The confinement is fixed means, there is no lateral pressure, in an way there is no lateral pressure. So, only vertical pressure is there. So, this is the major drawback in direct shear test.

Now comeback to, we will discuss direct shear test as well as your shear, as well as your triaxial test in the next following few classes.

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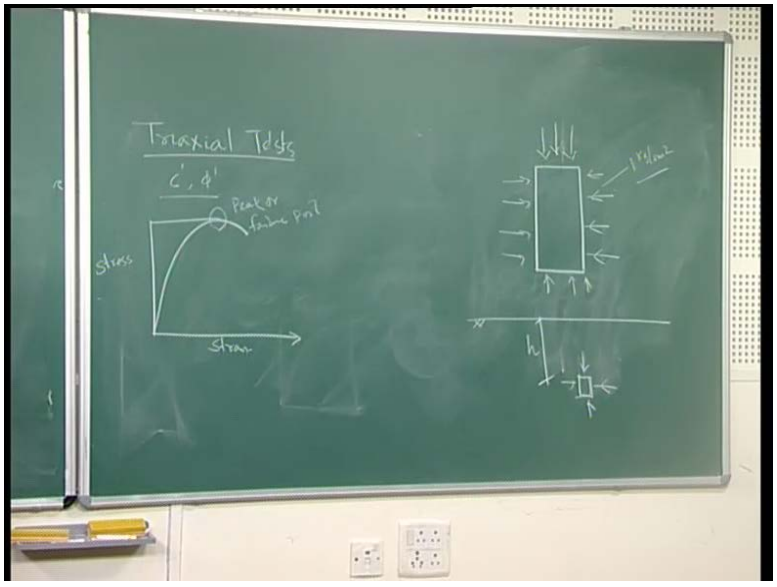

Now, next is your triaxial test ((no audio 16:32 to 16:45)). I will show animation later about the equipment, how the triaxial test has been performed in the laboratory, by means of power point presentation, may be sometimes later.

So, in triaxial shear test or triaxial test, what does it mean? Why it is called triaxial test? If this is a soil sample. Why it is called triaxial test? That means, this stress applied all round, it can apply stresses x y z, or if it is a cylindrical co-ordinate, (( )) if it is a circular

shape, or if it is a cylindrical shape, you can apply stresses all around, vertical as well as confining all around.

That means, it will truly simulate the moment you take, soil sample at any depth below the ground surface. That means, what will happen. These soil sample has vertical as well as lateral stress.

To simulate this soil sample below the ground surface is vertical, lateral or all around x y z, all around directions stresses. To apply to simulate, exactly these (( )) condition, these triaxial test has to be performed. So, what you are suppose to get in triaxial test.

Before, I go to explain this particularly triaxial test equipment and what are the, how these test has to be performed. What parameter you are suppose to you are interested to find it out. One is c prime, other is your phi prime, cohesion and angle of internal friction. The process is same, you can observe from there stress versus strain, how to get your stress.

By applying your vertically load, you will get this stress applied, increase in stress applied. So, laterally confinement already it is there, lateral pressure is there. So, how much it is displaced this strain you can get it.

Stress versus strain if you plot it, you will find it out, failure stress peak or failure point. From there, with application of particular load or may be stress, what with increase in stress, the soil sample with a particular confining pressure. Suppose, this is a confining pressure, say 1 k g per c m square. With this 1 k g per c m square, how much stress it can apply, how much stress it can take before the failure? So, you just apply load and increase it, or apply this stress increase it. So, that stress versus strain, you will get it for particular confining pressure, you will get your peak or failure point.

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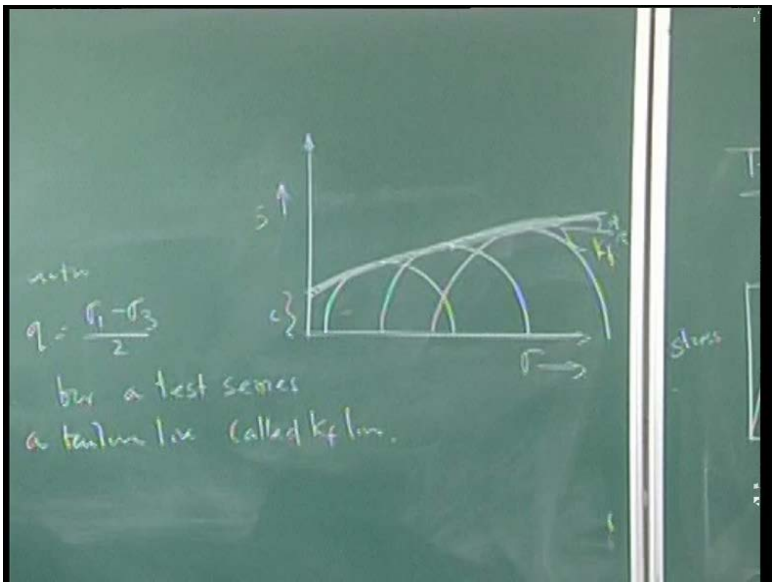

Now, there are, as there are two parameters. So, you have to do minimum two tests to get your result. That means, in that case, shear stress versus normal stress, if I plot it. If I draw the mohr circle, so draw the mohr circle and find it out the common tangent. With this point, draw a tangent, where it touches the mohr circle or the failure point. So, this will give c, and this will give your phi.

With this maximum number of, at least for as the way I said, for your direct shear test, in case of triaxial test, minimum number of test required to be performed. As there are two parameters c and phi, minimum required is two. Generally, we go for three samples, we will get a good result. So, minimum two number of samples are required. So, that you will get c and phi.

So, now next terminology is stress path. So, instead of plotting a mohr circle for each stress condition, it may be more convenient to plot stress co-ordinates of p. p is equal to sigma one plus sigma three by two, q is equal to sigma one minus sigma three by two. So, this locus of these points p q. I am just writing the locus of points or locus of p q points for a test series on a soil forms a failure line called K f line.

Now, this is your failure, but failure line, it is at the middle K f line. K f line is different than your failure plan p q diagram from you will get there, your K f line.

Now, what is this, the moment you are saying that triaxial test, how you will get it sigma one and sigma three.

What is your sigma one? Sigma one, stress coming in major axis and minor axis, or major principle stress or minor principle stress, you can say. So, suppose here, this will be your sigma three, lateral or confinement pressure coming all round, this we call sigma three. So, sigma one is your vertical pressure or vertical stress applied.

The moment you want to draw mohr circle, what you will do. You will take shear stress versus normal stress, from where you will take your sigma three, take your sigma one from this co-ordinate axis zero zero. With this, draw the mohr circle, half of the mohr circle. Now, question to all of you, why half of the mohr circle has been drawn, why not full? Though it is, it says it is mirror image of this or still that you have to say, why this we plot all where else, this half of the mohr circle, not the full, means only half. If I draw a mohr circle, it is like this full. Only half of the mohr circle has been drawn, in case of geotechnical engineering.

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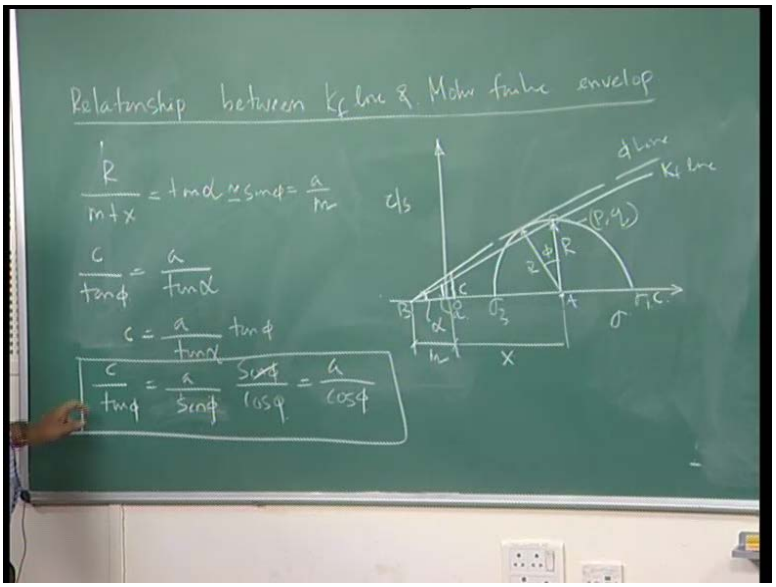

Now, we will go for next part is your relationship between K f line and mohr's failure envelop ((no audio 25:10 to 25:55)). The tangent which touches your mohr circle, that is your, you can say, that is phi line or failure line from you are getting, from your standard triaxial test for three sets of confining pressure. Sigma means sigma three one, sigma three two, sigma three four or three three, but here p q with this stress path, it is passing

locus of this point of the p q, it will be around in the middle. So, 1 2 3, this is your K f line ((no audio 26:47 to 26:26)).

This is your phi line. This is your K f line. This is my sigma one, sigma three, R R this is your phi, and this will be c, and this will be a, and this will be alpha, and from here to here will be m. R by m plus x, and this distance is your x, tan alpha which is equal to sin phi, which is equal to a by m. c by tan phi, a by tan alpha. c is equal to a by tan alpha, tan phi, which is equal to a by tan alpha, sin phi by cos phi. So, which is equal to a by cos phi. a by tan alpha, c is equal to a by tan alpha into phi, alpha is equal to phi, it is equal to tan, it is equal to sin phi which is equal to a cos phi.

That means, If I draw a simple mohr circle, and draw the phi line, and K f line. phi line comes from your p q diagram, and phi line sorry K f line comes from your p q diagram, and phi line comes from this tangent, which touches this mohr circle. The intercept of phi line with this ordinate, that is your c, this to this distance is your c, intercept of K f line here it is a, and this angle is alpha, this distance from here to here you can name it, this is o, this is A, this is B and this is C, o b is m.

Now from simple geometry, look at this triangle, simple geometry m plus x by R is equal to tan alpha. With this simple geometry, tan alpha is equal to R by this distance. R by m plus x is equal to tan alpha. Sometimes in soil mechanics, this is very small, alpha is equal to, it may be as if phi, so which is equal to sin phi. If I write it in terms of sin phi, which is nothing but, a by m. These are the two similar triangles, so a by m. That means, c by tan phi is equal to a by tan alpha. So, from there c by tan phi is equal to a by cos phi.

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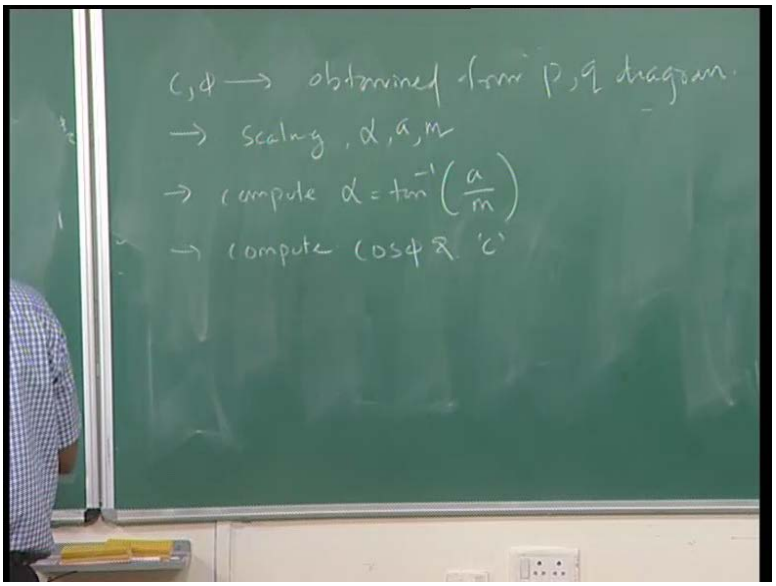

So, c and phi can be obtained from p q diagram. So, that mean this steps, so scaling alpha, a and m. Then, compute alpha is equal to tan inverse a by m. Then compute, cos phi and c. We will do this with a solved example write now.

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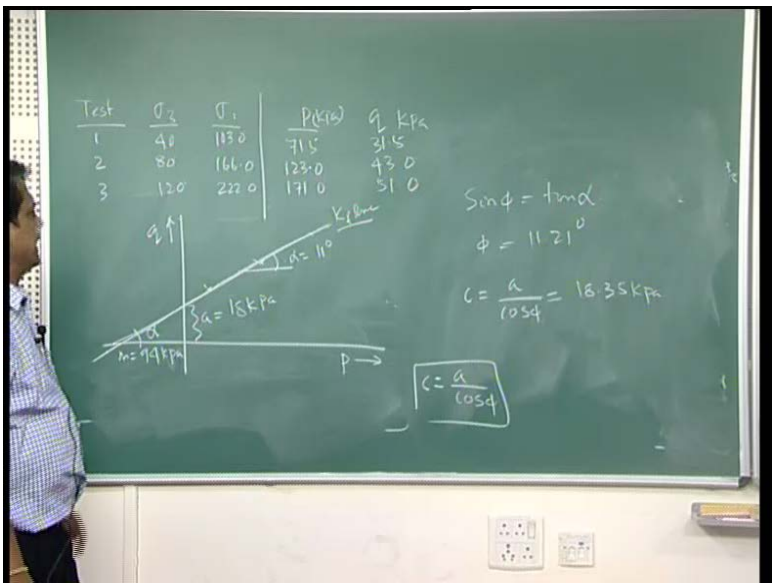

So, there is a given triaxial data. So, this is my test, 1, 2 and 3. Then, sigma three, sigma one is given, this is 40, 80, 120. Then, 103.0, 166.0, then 222.0. Sigma three and sigma one is given. From there, you can find it out, p and q in K p a. So, this will be 71.5, p and q how you will get it, p and q as I said earlier. So, p is equal to sigma one plus sigma

three by two, q is equal to sigma one minus sigma three by two. So, 71.5, 123.0, 171.0. q is equal to 31.5, 43.0, 51.0.

Now, this p q diagram has been, you plot with this calculated p q diagram. So, this is q, and this is p. From this, once you plot p versus q, you will get this is my K f line. Extend it K f line, it will intercept p somewhere else here, it will cut. From there, this is your value of a. So, a is equal to 18 K p a, then m is equal to 94 K p a. Then, alpha is equal to ,this is alpha, if you remember the last part is, this is your alpha. So, alpha is equal to 11 degree.

Once you plot the diagram, these are the set of test data as available from the triaxial three test. Sigma three, sigma one is given. Now, convert this sigma three, sigma one to p and q. Then once you get p and q, plot the your p and q diagram. Once you plot the p and q diagram, p and q, K f line draw. This K f line has to be extended, it will intercept the p, some angle alpha. Then graphically you measure, what is your alpha? Alpha is equal to 11 degree, a and m you can find it out, from this graph.

Once you get a, m and alpha. From there, you can find it out, sin phi is equal to tan alpha. So, phi you can get it, 11.21 degree. Then, c is equal to a by cos phi. As I said, c is equal to a by cos phi. Here you get it earlier, c is equal to a by cos phi from this relation. From there, you can find it out, 18.35 K p a.

That means, plotting mohr circle every time, it is a compression. So, you can make this sigma one and sigma three, in terms of p and q. Then, plot the p q diagram. From p q diagram find it out K f line. Once you get your K f line, alpha draw the means, find it out, from graphically what is angle alpha, a and m.

Once you get it, so there is a relationship between K f line as well as phi. So, sin phi is equal to tan alpha. From there, you can find it out phi and c is equal to a by cos phi. From there, you can get c is equal to 18.35. That means, once set of triaxials results are there, I can get p q diagram from there, I can get c and phi, or I can plot this mohr circle, I can get directly c and phi.

We will discuss more in the next class.