Geotechnical Measurements and Explorations
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Lecture No. # 16

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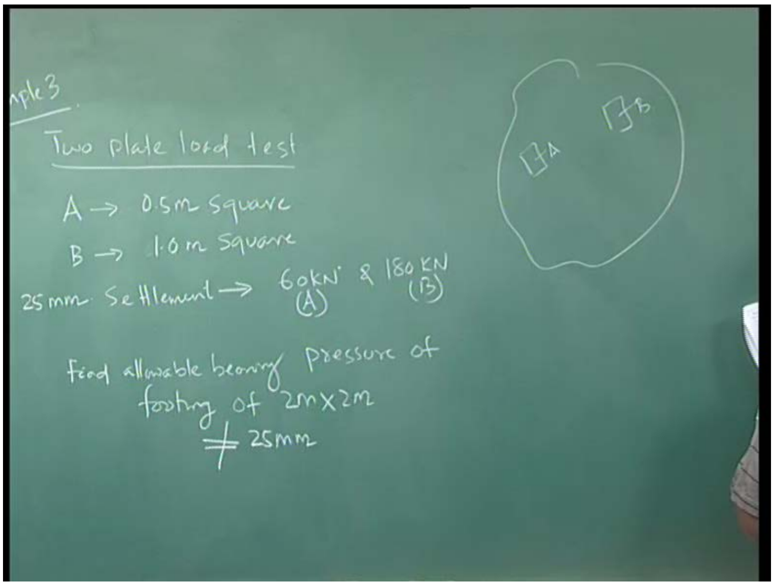

Example three: Two plate load test conducted on a site; one plate say A - plate A, a size 0.5 meter square, and plate B, a size 1.0 meter square. So, for a settlement of 25 mm, the load found to be 60 kilonewton for plate A, and 180 kilonewton for plate B. Determine allowable bearing pressure or maybe you can say find allowable bearing pressure of footing of 2 meter by 2 meter with a settlement not exceeding 25 mm. This is the third example, question is in a site, in a site, there are two plate load test has been conducted; one is A, other is your B. So the size of plate of A is 0.5 meter square size and B is 1.0 meter square size, and it is expected 25 mm of settlement, happened a no failure load occur with respect to 25 mm of settlement, plate A load failure load is 60 kilonewton, plate B is 180 kilonewton. Find allowable bearing pressure of footing, square footing of size 2 meter by 2 meter.

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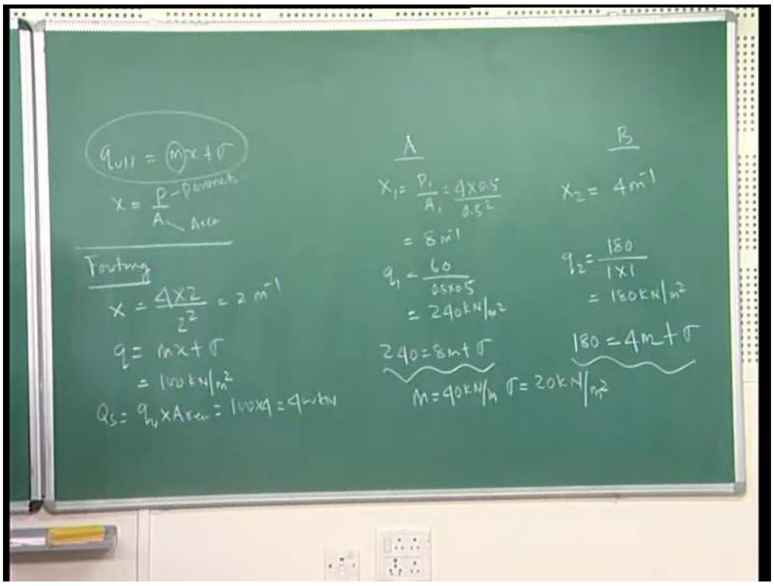

Now so q ultimate, if I write it, m x plus sigma; so x is equal to P by A; so, for for first plate load test say A, and second plate load test say B. So, X 1 is equal to P 1 by A 1, so P is perimeter, A is equal to area ratio or area. So in that case, 4 into 0.5 by 0.5 whole square x 1 is equal to 8 meter in inverse. Similarly, X 2 for plate 2, it will be 4 meter inverse; q 1 is equal to how much load it is given? Failure load is given 60 kilonewton; with this 60 by area, 0.5 into 0.5, which is equal to 240 kilonewton per meter square. Similarly, q 2 for plate 2, which is equal to 180 by 1 by 1, because the size is 1 meter square, so this will be 180 kilonewton per meter square. Now, if we look at here for first case, it will be for second case, it will be 180, q ultimate is equal to 4 m plus sigma; case one it is 240 8 m plus sigma. So from this, m is equal to 40 kilonewton per meter and sigma is equal to 20 kilonewton per meter square.

Now for real footing, these two parameters I got it from these two plate load test m and sigma; and from these for real prototype footing, x is equal to or you can write for real footing, x is equal to 4 into 2 4 into 2, this is a squares shape, so 4 into 2 perimeter divided by area, which is equal to 2 square, 2 meter inverse; and q is equal to m x plus sigma, where it will give 100 kilonewton per meters square, so Q s is equal to q u into area, which is equal to 100 into 4 - 400 kilonewton. This is another way of getting bearing capacity of footing; in this case, about soil profile nothing has been given. So, this has been given by (( )); so if there are two plates to load test at the side if you conduct, then you can easily get the (( )) parameter of m and sigma.

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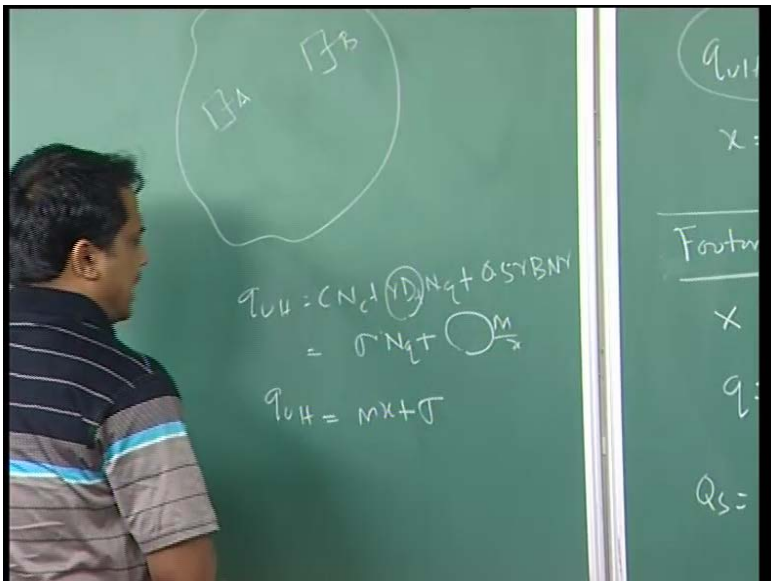

Because they say if you write it, q ultimate is equal to ultimate bearing capacity C N c gamma D f N q plus 0.5 gamma B N gamma, if we look at here, it will be if I take it sigma N q plus m into x, x is perimeter by area, so here this term will come m by x, N q and N gamma are constant; so that is why they have proposed, which is equal to in terms of m x plus sigma.

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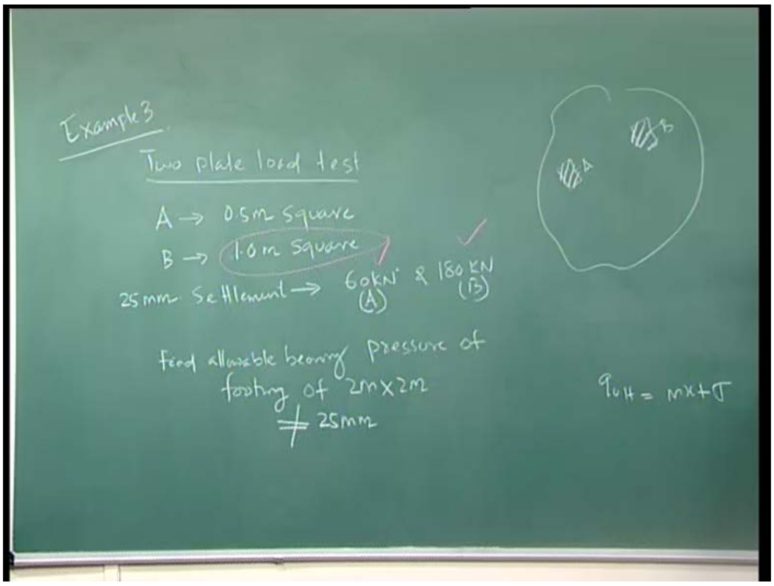

So that means there are two parameters; one is m and other is sigma; for two parameters, two unknowns that means two equations are required. So to get that, at least you have to do testing at least two plate load test required. So here in this example, two plate load test was conducted were conducted; for plate A, the size is 0.5 meter square and plate B, 1.5 meter square, and up to 25 mm settlement the failure load observed 60 kilonewton and 180 kilonewton. With this, you find it out what is the value of x; x is nothing but perimeter to area ratio. For plate A, x you find, for plate B x you find. Similarly, ultimate load or q you can find it out failure load divided by area; so this is your failure load for plate A, failure load for plate B, so q 1 you will get it, q 2 you will get it; with these parameters you can find it out what is the value of m and sigma.

As these two plate load test has been conducted in the same side, so for real footing, same formula can be applicable; and this this same formula has been applied. And for real footing, you find it out x and as well as means, q you can get it, because you have m value you know, and sigma value you know; this is your m value and sigma value, you get it from the plate load test. From there you can find it out q; once you get q, this is your ultimate load you can find it out safe or how much is your total load coming, total load carrying capacity of this footing you can find it out.

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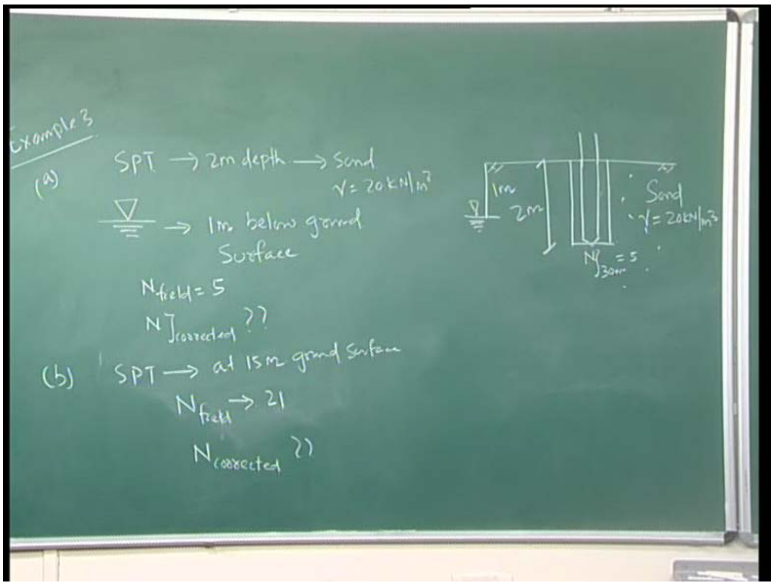

Now come to example 3: A SPT that means Standard Penetration Test, SPT conducted at a depth of 2 meter depth, soil is sand and gamma is equal to 20 kilonewton per meter cube. Then water table, water table for the site is located 1 meter below ground surface; the N value was observed to be N field - 5. Then it has been asked, what is the N corrected? (No audio from 11:42 to 11:52) Now, next part is this is part a; part b is at the same side, SPT conducted at 15 meter ground surface. N value, N field is observed to be 21; then asked what is the value of N corrected.

Now initially, what is the question? Question is this is ground surface, and standard penetration test has been carried out below 2 meter, this is 2 meter, so SPT test has been carried out below 2 meter; and this entire soil is sand deposit, gamma is equal to 20 kilonewton per meter cube. And there is a water table, we say that water table is there below 1 meter of ground surface; now n field n for 30 centimeter below, which is equal to 5. Now find the… Case 1, find the corrected value. Now, what are the two corrections, supposed to be or what are the corrections applied in standard penetration test.

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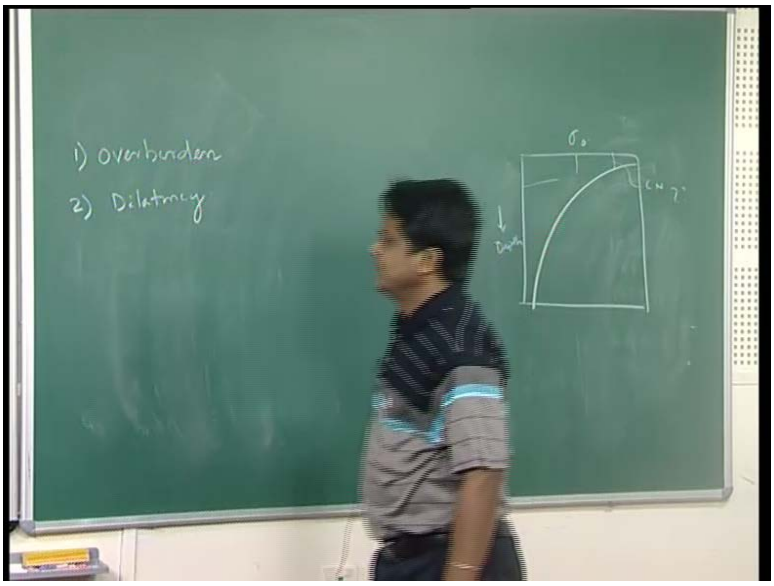

There are two corrections; one is your overburden, second is your dilatancy; one is your overburden correction, second is your dilatancy. Now, come to part 1 or a, what is the overburden at 2 meter depth, sigma 2 meter is equal to gamma into h; gamma is equal to 20 into to h is equal to 2, which is equal to 40 kilonewton per meter square. Now sigma prime is equal to because water table is at 1 meter; so it will be, below 1 meter, it will be water table effect, so definitely we will go for gamma submerge unit weight. So it will be sigma minus gamma w h prime, so here h prime is your 1 meter, which is equal to 40 minus 10 into 1, 30 kilonewton per meter square. Now if we look at there, there is a chart, with this overburden with this over burden, there is a chart, earlier I have shown, what is the value of sigma C N? We can get it from the chart.

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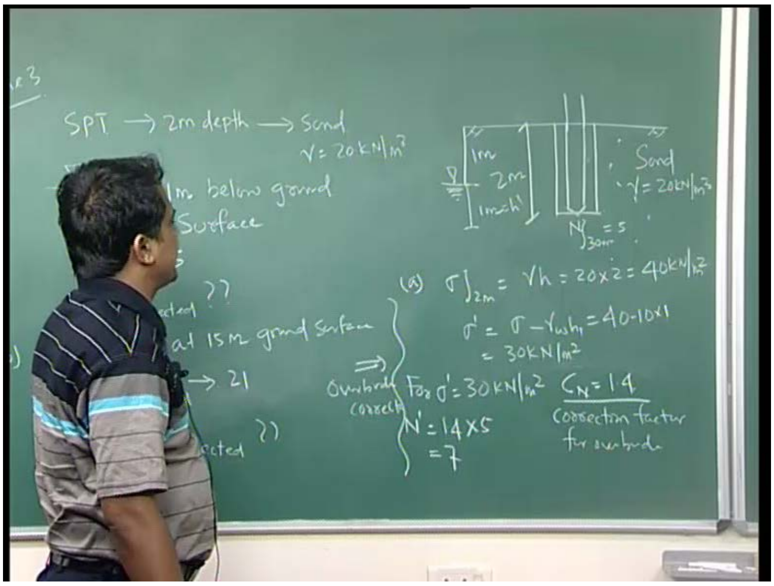

So with respect to sigma for sigma prime or effective stress over burden 30 kilonewton per meter square C N is equal to 1.4, correction factor C N is correction factor for over burden C N is for overburden. Now with this N corrected is equal to 1.4 into 5, which is equal to 7. Now next question is whatever part is this is your overburden correction. Now second part is your dilatancy correction. So, if there is an water table; is there any dilatancy correction? Yes. Then provide… At what condition dilatancy condition to be applied?

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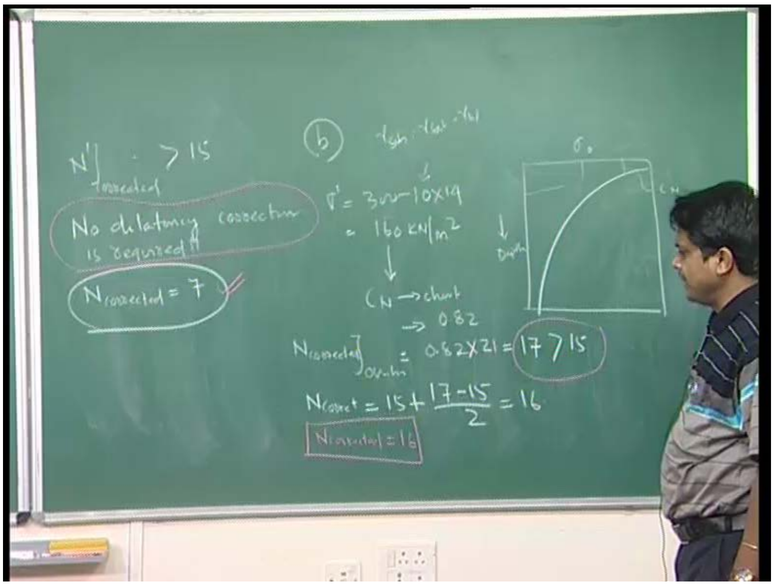

Dilatancy correction to be applied when N corrected our after overburden, N corrected after overburden is greater than 15. So in this case, N corrected after overburden correction, it is less than 15; that means no dilatancy dilatancy correction is required. Now similarly in this case, no dilatancy correction is required, so what is your total correction? N corrected equal to n corrected is equal to 7. Now come to part b; part b is it is proposed to carry standard sanitation test at 15 meter below the ground surface. This is ground surface that means in that case, overburden pressure is equal to at 15 meter 300 minus 10 into 14, because total is 15 meter; 1 meter you will leave it, below 1 meter there is water table, definitely gamma saturated you can do it gamma saturated value, because gamma is equal to 20, so gamma saturated is equal to gamma submerge is equal to gamma saturated minus gamma w.

With this 20 minus 10, it will be 10; so sigma prime means overburden pressure is equal to 160 kilonewton per meter square. With respect to this, your C N from chart, it will be 0.82. Now N corrected for overburden is equal to 0.82 into 21, which is equal to 17; as it is greater than 15, as this overburden correction is greater than 15, again condition is that water table is lying below 1 meter, then this dilatancy correction is going to apply. Now fordilatancy correction N corrected, which is equal to 15 plus 17 minus 15 by 2, which is equal to 16. Now final N corrected is equal to 16. So in this example there are two cases one is your SPT has been carried out below 2 meter depth, other is SPT has been carried out below 15 meter depth from ground surfaces.

In case one, calculate your overburden, considering water table, then with respect to your over burden, find the correction for correction factor for over burden correction, and the N corrected is coming 7. As water table is lying at the ground surface, so dilatancy correction is required; again N corrected after over burden is less than 15, hence no dilatancy correction is required. So N corrected is 7. In case two, it is proposed to carry out your speed standard penetration test are 15 meter below ground surface; with respect to 15 meter, what is your over burden? Then with respect to overburden, correction factor for over burden has been calculated from this chart, over burden correction has been calculated, it is 17; as water table is lying in the ground, again N correction after overburden is greater 15. Hence dilatancy correction is required; and after the dilatancy correction, N correction is 16.

Now, next phase this is all about there are four examples based on, one is your plate load test two example last class, and one example is also today plate load test, third example is your… Fourth example, four example, this is your fourth example. So it is based on standard penetration test, how to do this correction, what are the corrections, how to calculate N correction - N corrected value?

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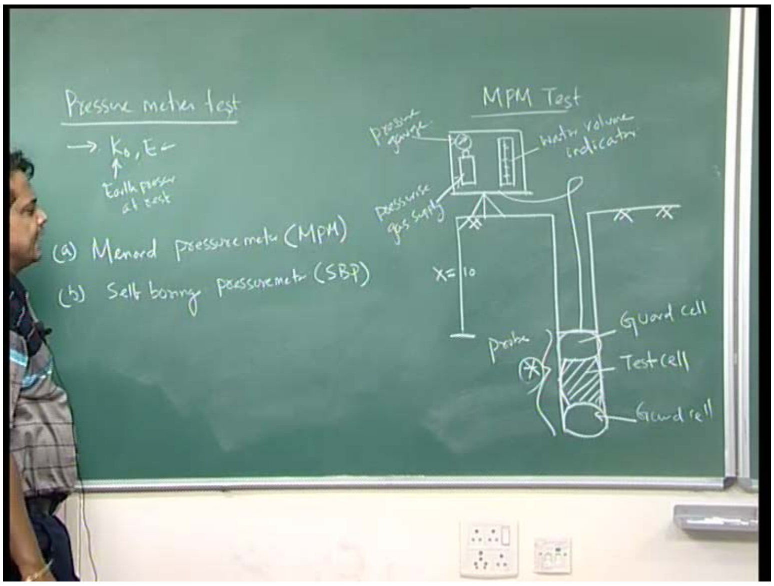

Now next phase is your pressure meter test. Why we go for pressure meter test? To measure k 0 and E in from in insitu condition; k 0 is your earth pressure at rest, and this is your modulus of elasticity. So there are two methods; one is your pressure meter test, other is your hydraulic fracture; it has two two test, it has application for different soils. So in this case, the pressure meter test, it will be particularly applied to any kind of soils, and there are two pressure meters; one is your Menard Pressure Meter - MPM; then second is your Self Boring Pressure Meter. Now we will discuss the generally menard pressure meter is widely used; so for this menard pressure meter test, I am just drawing this schematic sketch, where you can understand (No audio from 25:01 to 25:36) pressurized gas supply, this is your pressure gauge, water volume indicator, now this is called simply a probe; this is probe and it is guard cell, test cell probe consist of guard cell, test cell both the ends probe is guard cell in between it is test cell.

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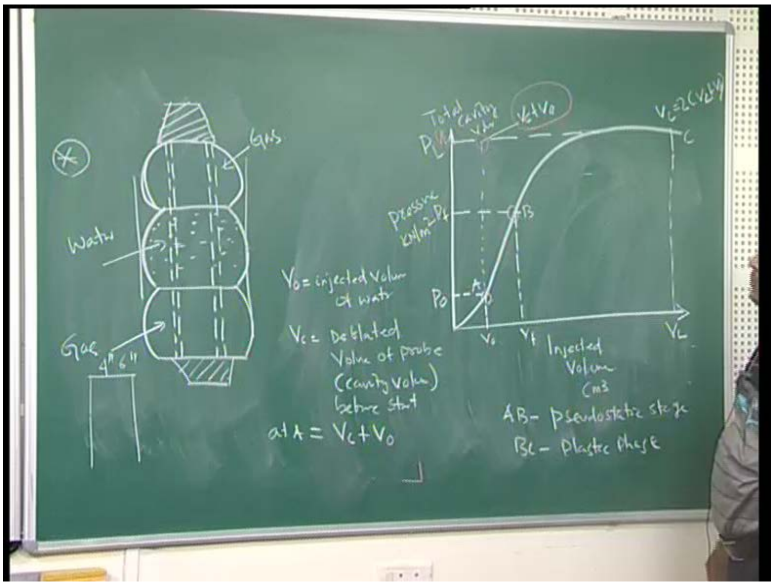

If I make this guard cell in bigger form…

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Now, this is one one guard cell one filled by gas, then this is your middle is your test cell, it is by means of water, then again bottom part is also guard cell, it is by means by your gas. So, pressure meter test a tentative sketch, I draw it detail means schematic sketch, generally in pressure meter test, what happen? Bore hole has been made; suppose it has been decided a depth of X, say 10 meter, 20 meter, 15 meter, 5 meter, you go and find it out what is the insitu k 0 and E? So in that case this is called completely this is call completely a probe; this probe has been connected, this probe has been connected to outside, the system is there, where we can measure the pressure, where water volume indicator is there, how much water is in there inside and gas supply also there.

So once you enter the probe, what will happen? Guard cells at the bottom and the top, guard cell at the bottom and the top filled by means of gas. Then with the help of water, this is gas, this is gas and the test cell filled up by means of gas; by means of water once you are applying, if this is my soil, corresponding soil here, so what will happen? If this is the bore hole, so it will try to expand both the way, both the direction it will try to expand, so that means the soil will be expanded laterally; once you increase the level of water, so it will try to expand the volume; once it expand, side wall be your, it is your soil; so soil contact this cell, it will try expand laterally. So you know, what is the value of gamma h overburden here that is your sigma 1.

Now, k 0 you can find it out, k 0 is equal to sigma 3 by sigma 1; sigma 3 is your lateral pressure, and sigma 1 is your over burden or vertical pressure; so sigma 1 you can calculate, how do get sigma 3? So, it will expand, it will try to push the soil both the sides; once soil fails, once soil fails, the expansion will stop or it may goes somewhere else or remains constant; that means we further expansion no change in volume, no change in volume or no change in further addition of water, no change in volume; that case you consider as a sigma 3 case. So once you get sigma 3, and with the help of gamma and height, at what height you are doing, you can calculate sigma 1, then easily you can get k 0 or pressure at rest.

Now, what is the what is the graph it looks like? If I draw pressure verses volume change, this is pressure kilonewton per meter square; this is your injected volume in centimeter cube. How do you get the volume changes? Indicator you are getting, how much you are adding water inside, accordingly volume will be changing. Then with expansion change in pressure inside, you can measure it by the means of pressure gauge. So the curve will go, this is A, this is your B and this is C; P 0 P f, V f, this is your P L and this part will comes somewhere else here, it will be V L.

So in this case, V 0 is equal to injected volume of water at the beginning; V c is equal to if I write here in this side total cavity volume, so then it will be V c, then this will be your V c plus V 0, then this will be V L is equal to 2 V c plus V 0; V c is deflated volume of probe or it is called cavity volume before start. So the volume of cavity at A at

A which is equal to V c plus V 0; A B generally called pseudo static stage; B C is your plastic phase. If we look at here, what is V c? V c is nothing but your plated volume of probe, suppose there is a bore hole has been made, bore hole has been made, suppose diameter is say 400 or may be 4 inch 4 inch bore hole or may be 6 inch bore hole. So what will happen? Initially the probe you have to deflate it, so that is touch, it should touch both the end of this borehole. So, that volume, initial volume before start it is called V c.

So the V c is initially, so if I write this is my V c, then what happen? Once you applied injected volume, so at point A it will be V 0, so V 0 is your injected volume of water, with the help of water it expand; but initially the volume is V c, so that is why at this point, the volume will be your V c plus V 0. So it will go elastic, then after some time, it reaches plastic deflated volume. So when when volume is equal to V c plus V 0 twice the volume, at that time general it has been considered the value of sigma 3 achieved; or may be to go elastic then plastic, and there is no more further change in volume, that point you can consider as a from the pressure you can take it as sigma 3. So once you get sigma 3, once you get sigma 1, then you can find it out later earth pressure.

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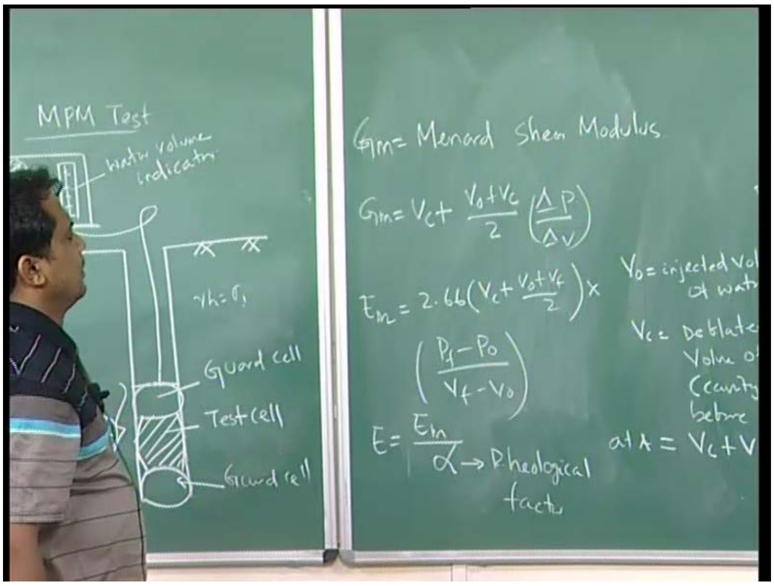

Now, what is the co relation it is here? G m, suppose G m is equal to Menard shear modulus. So G m generally calculated, it is V c plus V 0 plus V c by 2 delta P by delta V. E m is equal to 2.66 V c plus V 0 plus V f by 2 into P f minus P 0 by V f minus V 0. So you can calculate E is equal to E m by alpha; alpha is equal to rheological factor, alpha is equal to rheological factor; for different soils, for different soils, there is a chart, alpha you can get it, from there you can find it out E.