**Geotechnical Measurements and Explorations**

**Prof. Nihar Ranjan Patra**

**Department of Civil Engineering**

**Indian Institute of Technology, Kanpur**

**Lecture No. # 14**

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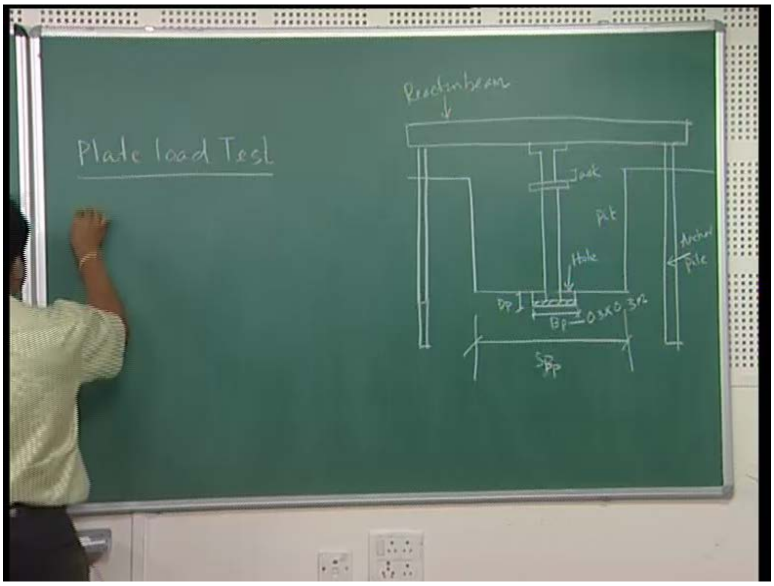


Next part is your plate load test. (No audio from 00:20 to 01:39) Plate load test has been conducted to find it out the bearing capacity of plate, as well as settlement profile of this plate, from these plate load test results, this can be co-relate to or maybe you may find the plate load test means bearing capacity of footing, and as well as settlement of footing.

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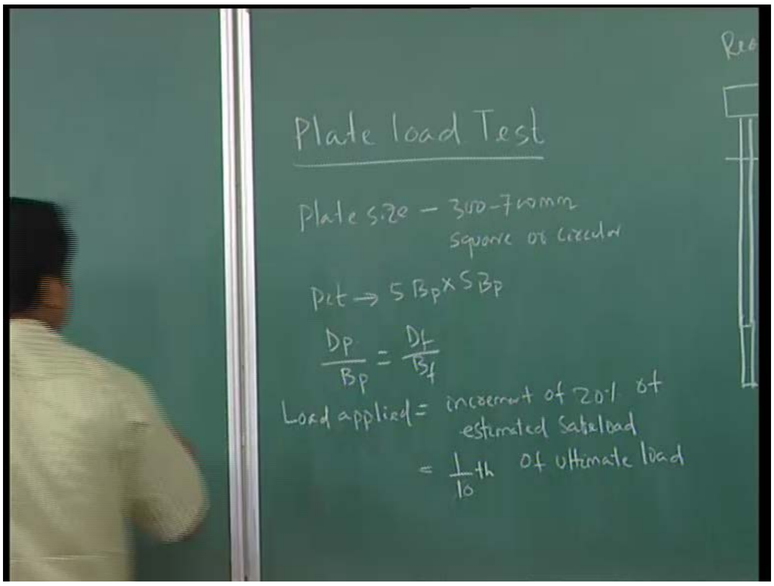
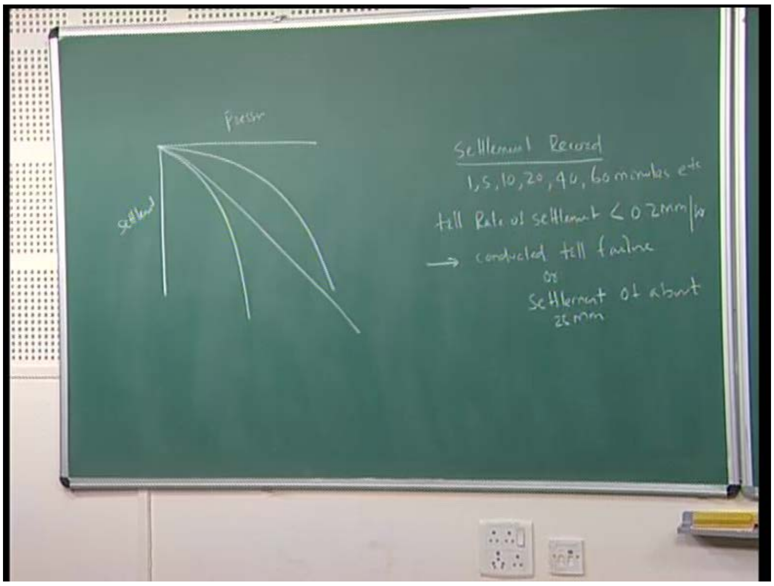



It is plate size is 300 to 700 mm, either it is square or circular. So, pit size is five times width of the plate, so from here D p by B p is equal to D f by B f. So, load load applied increment of 20 percent of estimated safe load or is equal to one tenth of ultimate load. (Refer Slide Time: 04:26)




So, settlement record settlement record is 1 minute, 5 minute, 10 minute, 20 minute, 40 minute, 60 minutes, and rate of settlement till rate of settlement less than 0.2 mm per hour. How far this test can be conducted - it can be conducted till failure or settlement of about 25 mm. What is the output pressure, here it is settlement.

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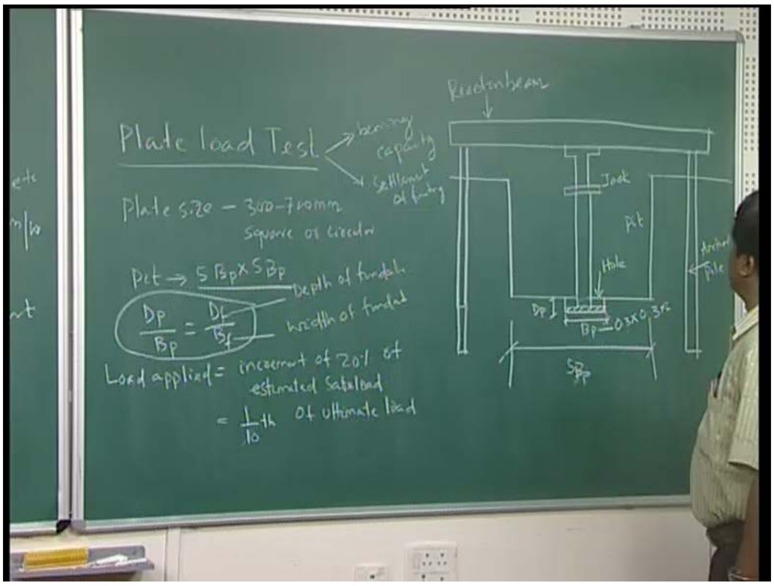


Now, come back to next part is your plate loads test, in this plate load test it has been conducted to find either bearing capacity, and or settlement of footing. Now, generally the available plate size is 300 to 700 mm square or circular, so it it is preferred if it is square or circular rectangular plates as far as possible it should be avoided, because of this get scale effect. Now, how do decide the depth of the mean depth depth of the pit, if you look at the depth of the pit, it is five times five times width of the plate.

That means the width of the pit, if this is the pit it should be five times B p, here it is also five time B p; B p is your width of your plate. Now, this decision has been taken based on that, this is your real depth of foundation, and also width of foundation.

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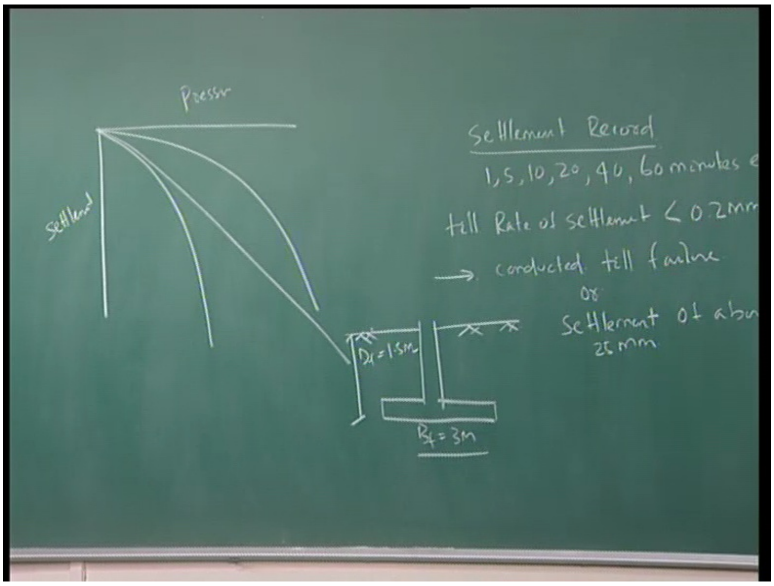


Suppose, it has been said a sterix footing or may be an isolated footing has to be constructed in that area, where the your planning to go for a plate load test, that it is depth of the foundation is say 1.5 meter, width of the footing width of the footing say 3 meter. So, once width of the footing, and depth of the foundation is known, if you want to find it out what should be the expected settlement, and bearing capacity of footing. Then, you will go for a in situ or may be plate in situ plate load test, in that case this pit size can be determine pit size can be determine based on the depth of foundation, and width of foundation from there you can find it out pit size.

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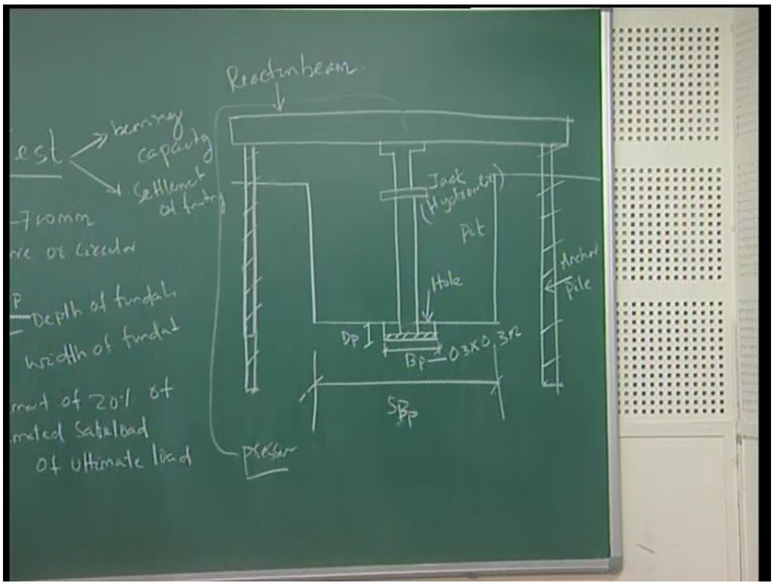

In this pit there is it how the how it works. Once, you made the pit at the side there are two anchor piles, these are the two anchor piles; above the anchor pile there is an there is a reaction beam, this reaction beam has been connected by means of a jack - hydraulic jack. Then at this end in the m at the end the bottom of the pit, plate has been placed, and this plate has been connected; the plate has been connected by means of hydraulic jack. So, outside this hydraulic jack, you apply the pressure; the moment you apply the pressure hydraulic jack try to uplift, try to go up, once it will go it will stick here, this entire load from here it will be taken by the reaction beam, each action has equal and opposite reaction. So, as it has been tied of by anchor piles, so the reaction will automatically come into the plate. So, it will apply pressure to the plate.

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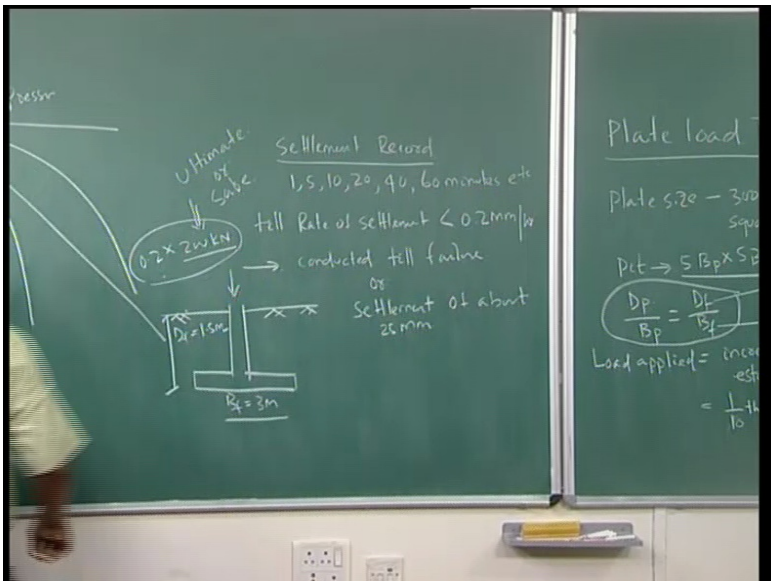


So, how do you decide what kind of pressure you are going to apply, suppose estimated suppose estimated safe load is 200 kilo newton. Now, 200 kilo newton means, it says load apply is increment of 20 percent of estimated save load, so 220 percent you make it, then same increment one by one, one by one you go or one tenth of ultimate load, whatever load available means what is the load applied to real footing, suppose say it is 200 kilo newton.

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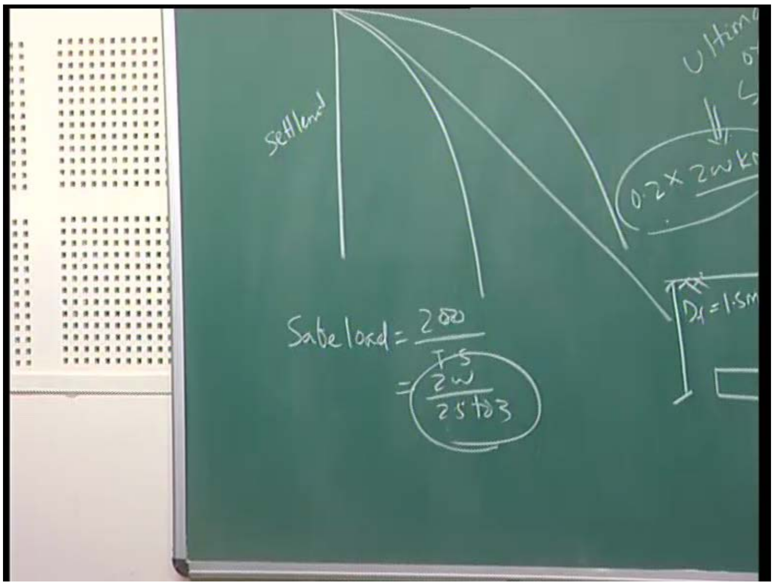


Now, check whether it is ultimate or safe; if it is ultimate load, then safe load you can find it out 200 by factor of safety, generally fact of safety has been taken 2.5 to 3. Now, each increment, suppose let us say initially you start with 10 tell 10 kg or 10 kilo newton of pressure, once you apply the 10 kilo newton of pressure, you apply continuously 10 kilo newton of pressure. So, what will happen? Here, you make arrangement of dial guages at the two opposite sides of your plate.

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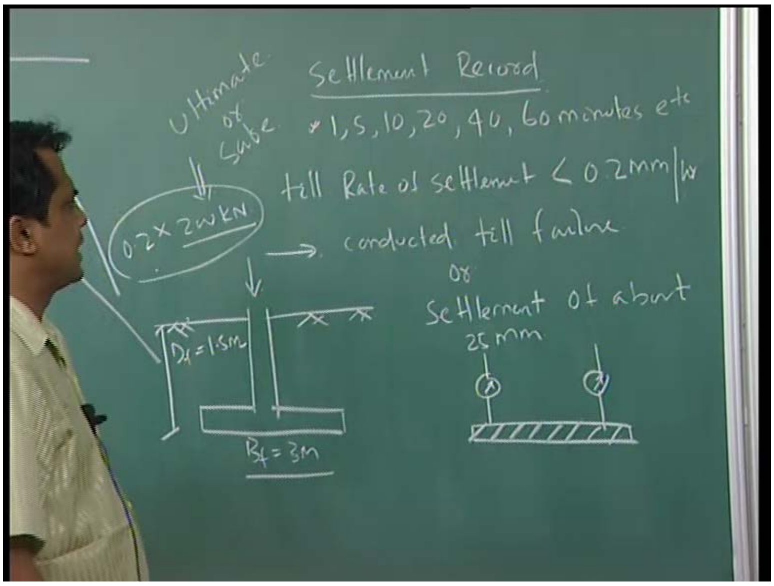

That means this is the plate at the two opposite sides of the plate arrange dial gauge, so you can record your dial gauge reading. The moment you apply, suppose say 10 kilo newton of pressure or 10 kg of pressure, you have to apply continuously, And record the settlement record the settlement here, 1 minute, 5 minute, 10 minute, 20 minute, 40 minute, 60 minute, 120 minute; it is always double, and you just apply the pressure continuously, and record the settlement.

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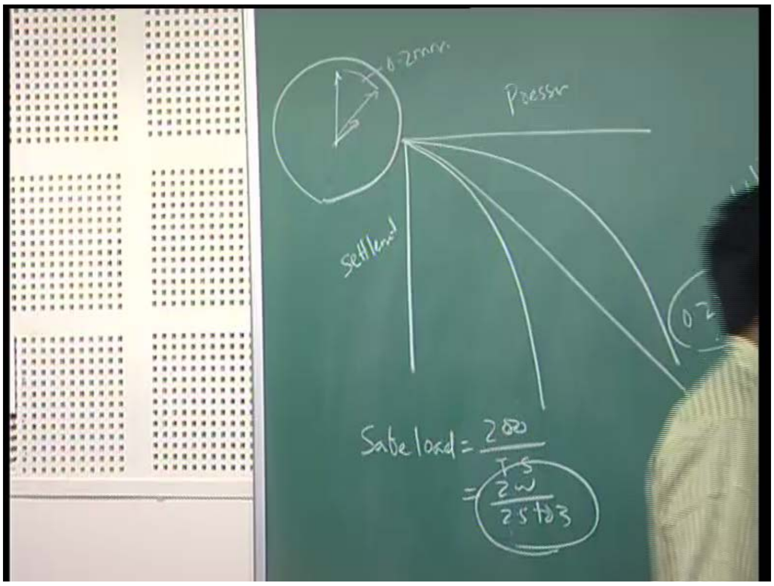


Now, how far you can record the settlement, you just apply till rate of settlement that means the rate of settlement will be 0.2 mm per hour; 0.2 mm per hour means, this is my dial gauge, so this is moving - hence this is moving. So, that means it will go only 0.2 mm in one hour, then at that point you stop then increase the load intensity increase the load intensity, suppose you have applied initially ten; that means you decided increment of 20 percent of estimated safe load or one tenth of ultimate load. Suppose, you apply 10 kg of this pressure, then you increase 20 next level, then you go. Similarly for 20 kg you apply continuously record the settlement at 1, 5, 10, 20, 40, 60; till you will get rate of settlement less than 0.2 mm per hour at that point you can stop

So, means you just continue, you continue your maximum limit - maximum limit of load apply is up to 25 mm, either till failure or maximum mm is maximum settlement is 25 mm, how do you know that it till fails if I plot pressure versus settlement.

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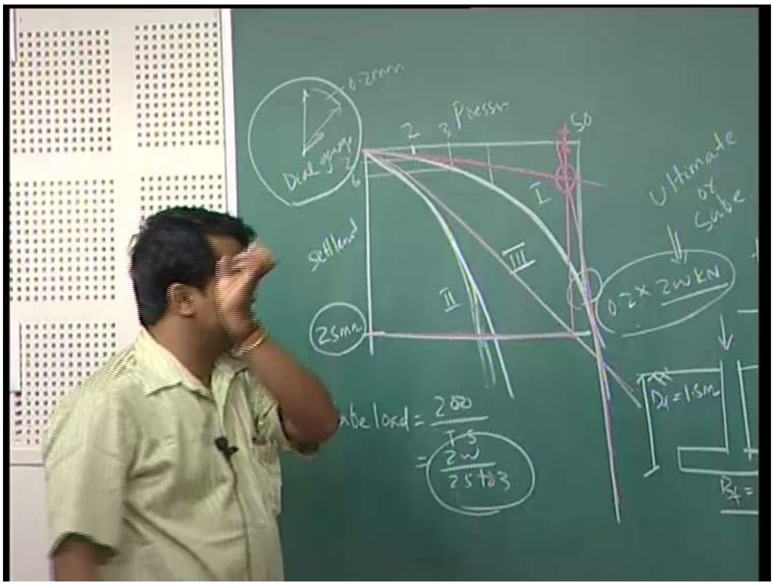


There are three types of curves; this is curve one, this is curve two, this is your curve three. In curve one the moment you apply pressure, the settlement will increase, increase, increase, increase all of sudden it fall down, it become asymptotic. Similarly, curve two also same thing it will increase, increase, and some harrells it is not asymtotic exactly, but after attending nully nearity it will continue.

In that cases for curve one, how do you know that it fails? That means, the moment you apply the pressure, the settlement will increase upto this point. Then, what happen with increase in pressure, the settlement will increase definitely, but the pressure will be remain constant. If you look at here, suppose here it is pressure is 10 or maybe say two, the settlement is say two, at this point suppose say it is three the settlement will be say six. So, every increment of pressure settlement will increase, but there is a certain point, at this point suppose pressure is say 50 50 kg per cm square pressure you apply, that means this 50 kg per cm square once you apply the settlement goes on increasing, settlement goes on increasing with the same pressure, that point you consider as a failure point.

If you do not get failure point like curve three, what will happen? You go upto settlement of about 25 mm, that means here once you record your settlement 25 mm by means of dial gauge settlement of 25 mm, that is a point you can stop this test. That means once again there are two conditions; conduct the plate load test, till you get the failure load or go for settlement of about 25 mm. It is recommended, you go for a settlement of 25 mm, and stop it before also you can you may get your failure load, you may not get failure load. Now, if this is the curve, curve one, curve two, and curve three; in the curve one how do I get the ultimate load; that means draw a tangent from the initial part of your pressure settlement curve, look at here.

Initial part of your pressure settlement curve is elastic draw a tangent. Similarly, bottom part that means the point where afterwards within with the same pressure intensity, the displacement increases you take it draw another tangent. The cross point intersection of two tangent intersection of two tangent, it gives it gives your ultimate load; this is my ultimate pressure or ultimate load, and here in this case as it is increasing with increase in pressure. So, there is not a, you are not supposed to get a very distinguish failure criteria or failure mode here. In that case you take 25 mm settlement corresponding to that the pressure is your failure pressure.

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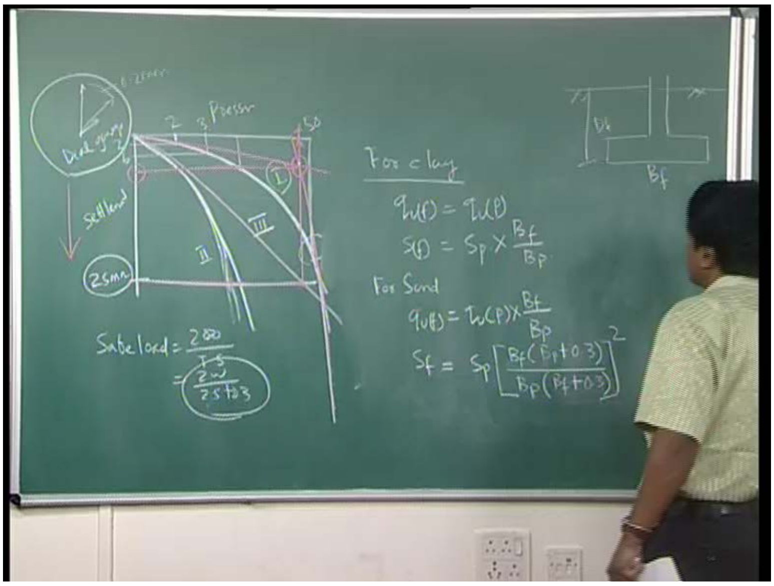


Now from this there are correlations for cohesive soil as well as for cohesiveless soil to get ultimate bearing capacity and settlement of footing or clay q u(f) is equal to q u(p), and settlement of footing is equal to settlement of plate into B f by B p; for sand q u(f) is equal to q u(p) into B f by B p, and settlement of footing is equal to settlement of plate into B f B p plus 0.3 by B p B f plus 0.3 whole square.

Now, once you know from here ultimate load of plate, then you can correlate you can find it out, you can find it out the ultimate bearing capacity of footing in sand as well as in clay. Now, suppose this is a footing, this is given footing, and this is your depth of footing; now for clay ultimate load capacity of footing is equal to whatever you get from ultimate load capacity of plate, and settlement of footing is equal to settlement of plate into B for width, remember B for width - width of foundation, and width of plate.

Similarly for sand, ultimate load is equal to ultimate load of plate into width of footing by width of plate, and settlement of footing is equal to settlement of plate into B f into B p plus 0.3 by B p into B f plus 0.3whole square. These are the correlations has been given, once you know the plate load test; from plate load test once you conduct the plate load test from plate load test you can get two parameter, one is your ultimate bearing capacity also settlement at failure, settlement at failure.

If somebody says this is the ultimate from this curve one, type curve one - this is the ultimate failure capacity of plate. Now, corresponding two ultimate failure capacity of plate corresponding two ultimate failure capacity of plate, this is the failure settlement; as settlement has been plotted in vertical directions. So, this is the curve failure settlement corresponding to ultimate load.

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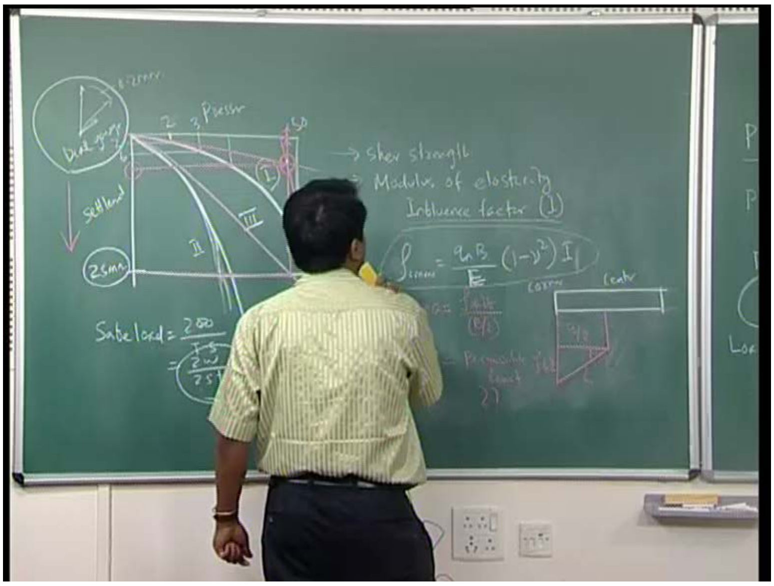

Now, what are the other parameters from this plate load test we have supposed to get; we have supposed to get other parameters from their, if from this test, we can get it shear strength, modulus of elasticity. So, let us say also you can find it out influence factor - influence factor I, where this influence factor has been used, this influence factor it has been used in immediate settlement; in immediate settlement - immediate settlement calculation it is q n B by E 1 minus mu square into I. I is nothing but your influence factor.

So influence factor at the centre as well as at the corner, if this is the plate or this is a footing, this is a footing what is the influence factor at the corner, if this is my corner; and what is the influence factor at the centre. Now, why this influence factor is required? Influence factor has been used to calculate this immediate settlement in a footing; in a footing the influence factor at the centre, and influence factor at the corner if I know, then immediate settlement at the corner, and immediate settlement at the centre can be determined.

From this what we are supposed to get from this we may get the differential settlement of footing, because of the differential settlement if if you know very well, because of differential settlement from the corner the cracks - building cracks. Once you know the differential settlement, and you can check whether this is in within the permissible limit or not, if it is B by 2, and this is the difference say row difference. So, tan theta is equal to tan theta is equal to rho difference by B by 2, and check whether it is within the permissible limit or not. So, can I get this influence factor from this plate load test - yes, we can get the influence factor. Can we get the modulus of elasticity? Yes. We can get the modulus of elasticity. Again where this modulus of of elasticity has been used, this modulus of elasticity has been used also again calculating this immediate settlement, and design parameters, and design parameters. If you look at here, E has been used to calculate the immediate settlement, now you now we can go one by one to calculate this how you are going to calculate influence factor, and modulus of elasticity we can discuss.

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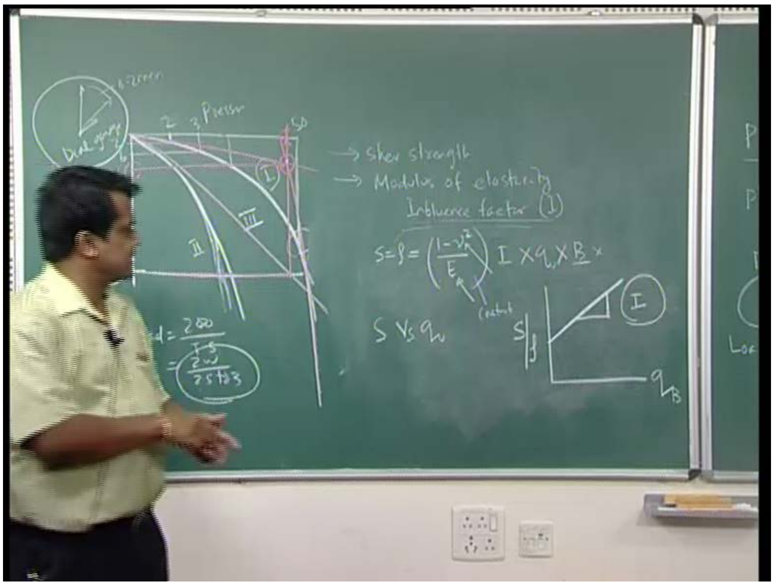

Now, if I write settlement S or row some, some harrells people say settlement S, some harrells some books say settlement is equal to rho, which is equal to 1 minus mu square by E influence factor into q into B. So, if you look at here, 1 minus mu by E soil modulus of elasticity and mu; these are the constant, so the whole term is constant, it is not varing. Now, B is also a constant, it is not varying. Now, if I plot S versus q whatever you are getting from plate load test, so how this graph looks like; this is S settlement or you can say that row, this is my q ultimate bearing capacity of footing or may be ultimate bearing capacity of footing, then you plot for different different different pressure intensity; different pressure intensity or you can take from here the settlement, you plot it, it will follow the graph will follow like this. And slope of this, and the slope of this is nothing but your influence factor I influence factor I.

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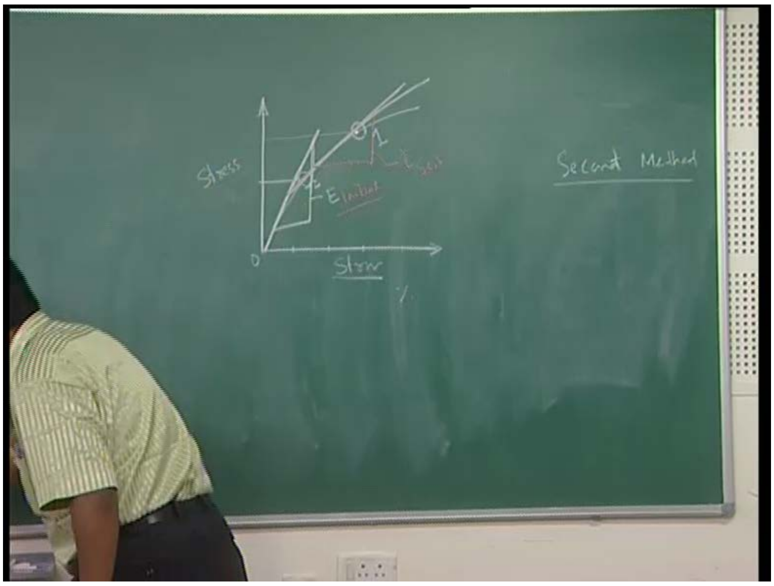


Now, next paragraph is your next next next part is your can I get modulus of elasticity E can you can get it, though I have not discussed the E, how to find it out E yet, it is a later part. Just in brief I am saying from stress versus strain, strees versus strain graph, you can get E by means of two methods: One is your initial tangent method; other is your second method.

So, in initial tangent method draw a tangent draw a tangent, initially where the linear part, once you draw the tangent and slope of that it will give your E modulus of elasticity. E is equal to nothing but stress by strength, now with this how do I get stress versus strain, pressure intensity is nothing but, stress. Now, strain can I get it yes, once you know the failure settlement, suppose say you know it 25 mm, so how much strain at the beginning suppose 2 mm, 2 2 mm settlement, this is your pressure is 2 kg per cm square. So with this 2 mm 2 by 25 mm, you can get it what is the strain in terms of percentage.

So, from this plate load test, you draw stress versus strain stress versus strain, once you draw the stress versus strain, then plot it, and take this initial tangent where you get this linear part draw one tangent, that is called initial tangent method. And slope of that is E. Now, second method is second method, in that point in this method how do you locate, how do you find it out E. First you choose stress corresponding to your safe load, stress corresponding to your safe load means, that you take it one part, then other part is your with respect to that 50 percent of that you mark it.

This is your point one, this is your point two with this draw a tangent with this draw a tangent, and slope of that it will be corresponding to second tangent or E second, this is your E initial. This I am going to discuss in details later on.

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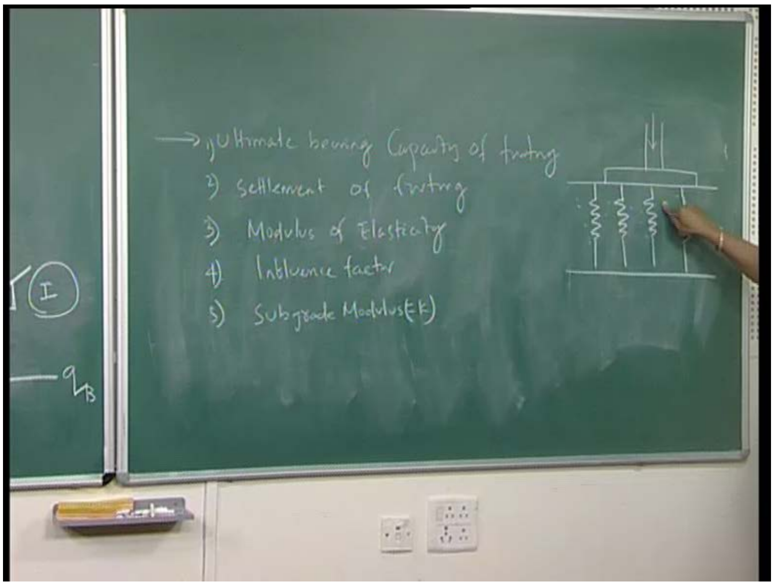


Now, what is the third parameter you can get it, what are the things till now from plate load test I can get it, if I conduct a single plate load test, from plate load test we can get it ultimate bearing capacity of footing - from correlation number one. Number 2 - settlement of footing, number 3 - we can get modulus of elasticity, number 4 - we can get influence factor, then number 5 - I can get sub-grade modulus, how these sub grade modulus comes in comes into picture.

If you go back to your footing beams on elastic foundation, suppose this is a footing resting on foundation by means of wind clerk’s model, so these are connected soil has been replaced by means of spring element. Footing is treated as a beam element, so that is why it is called beams on elastic foundation. Why soil has been replaced by spring element, because if you look at the soil profile here, whatever load coming to the footing it will transfer to the soil, then soil will be compressed in vertical direction.

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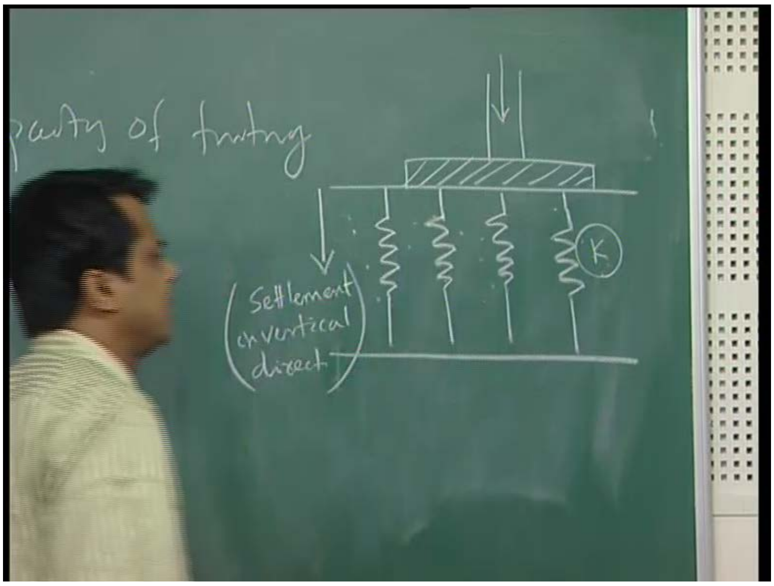


So, what is the major parameter, one is your settlement in vertical direction, that is why assuming the settlement will occur in vertical direction, the soil has been replaced by means of spring elements, this is called mechanical model. And this footing has been taken as beam element, with this spring constant k is required for design of design of foundation resting on soil. This spring constant k indirectly from pressure versus settlement, you can find it out what is that sub-grade modulus.

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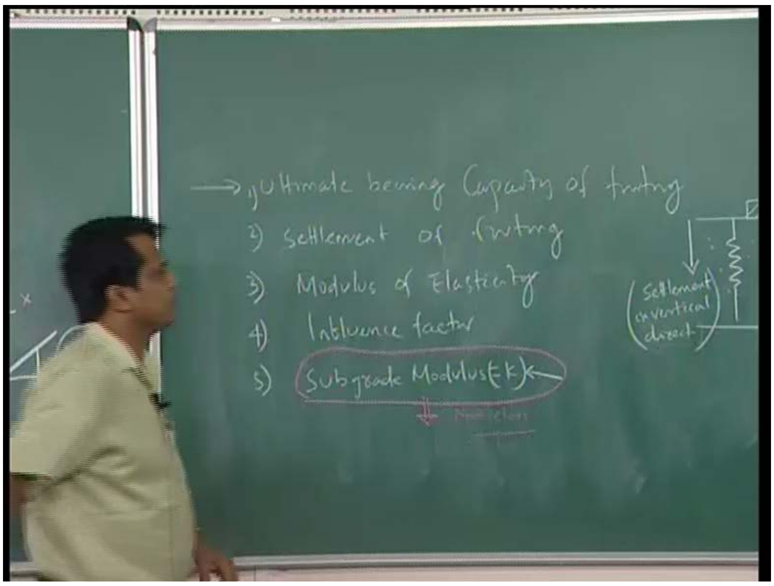

Its unit is different, then the spring constant k unit is different. We will discuss the sub-grade modulus k, and some more example solved problems in the next class.