Geotechnical Measurements and Explorations
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Lecture No. # 20
Geotechnical Measurements

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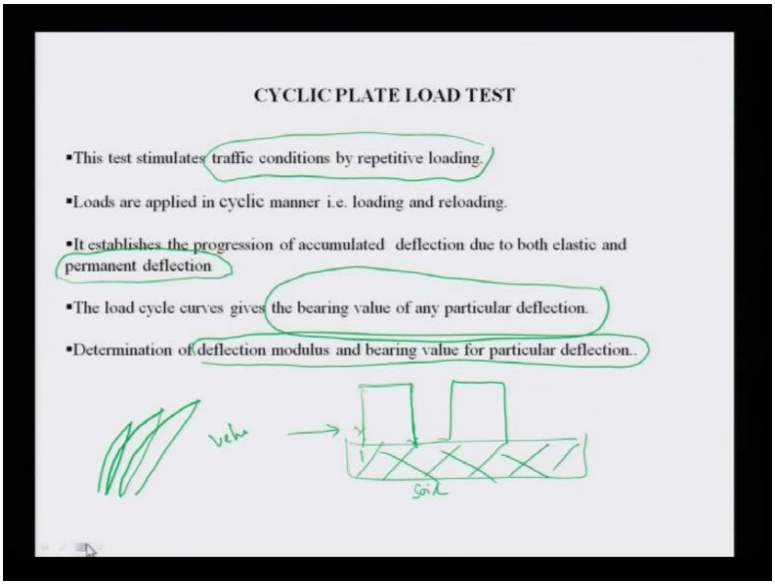

Last time we discussed about cyclic plate load test. So basically, once again I am repeating this test, stimulate traffic conditions by repeated loading, traffic conditions by repeated loading. And loads applied in cyclic manner, I mean loading and reloading. It basically establishes the progression of accumulated deflection due to both elastic and as well as permanent deflection. The load cyclic curve gives the bearing value of any particular deflection. So, determination of deflection modulus and bearing; the idea of doing this cyclic plate load test is to find it out deflection modulus and bearing value for particular deflection.

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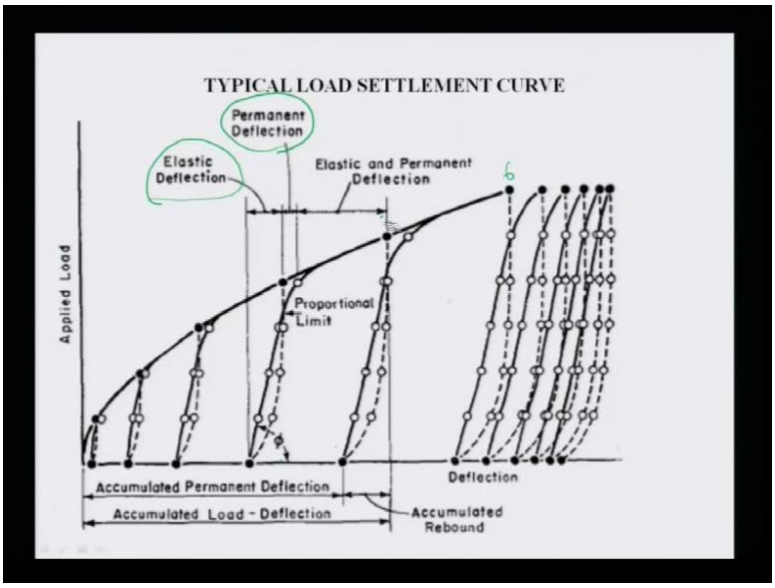

Now, if I show it this is a typical load settlement curve, if we look at here, from here to here load has been applied, by by means of hydraulic jack. Then once it get stabilize, then there is no more deflection by the dial gauges say the rate of deflection is about 0.02 mm per hour. Then next step instead of applying, this suppose this is first increment, this is second increment, this is third increment, this is your fourth, this is your fifth, this is your sixth. So, next step applying the second increment, enter load has been means, it has been unloaded, enter load has been released. So, this is the part of release; you can say this is the part of release. So, once it has been released, the displacement has been recorded by means of dial gauge; then after release, then next increment of load you apply increase up to 2, then it will proceed the path, this.

That means before applying second increment, so first increment of load 1, then it has been means unloaded; once unloaded, second phase you will reload it up to second increment that is your 2 kg per cm square. Once it is achieved second increment, again as per the procedure, again you unload it; you take it out second 2 kg per cm square. So then it will bounce, it will rebound, and you can find it out how much is your settlement; then again you do it. So loading and unloading case, if you go like this, so what will happen? You will find it out that there are up to certain certain level; there are up to this, there are two parts you can get; one is your elastic deflection means, the deflection where I will means, once you load it, then you unload it, it is suppose to return back to its original position.

So, this part of this if you look at here, this to this if I take it any part, here it is here it is coming back to the original position; if you look at here, at the third increment, it is not coming back, once I reload it, it is not coming back to the original position. Now, once it is not coming back to the original position, so what will happen? This is my… If I take an example, this is the starting, from where this load increment has been applied; then it has been unloaded. So, from here to here, this is called elastic deflection. As it is not reaching to its original positions, so this is called permanent deflection permanent deflection, and beyond this you can say that elastic and permanent deflection; so you can from this means cyclic load test you can find it out accumulated permanent deflection, accumulated load deflection from there, then accumulated rebound; how much accumulated rebound. If you look at here, how much accumulated rebound?

So from here to here, look it here, this is the position where and this is the position where, and this is up to this once it has been unloaded, this is my rebound. Similarly, in this case, it will be this is the rebound. So, it has advantage, because what happen in traffic in traffic load, it is load which has been applied by means of… If look at here repeated loading, means traffic in a road, there are passage means repeated loading how it comes into picture suppose for example, one truck or one bus or one vehicle it passes say it passes now.

May be after certain period of time, say two minute, four minute or six minute, may be one hour, same kind of load or same truck passes that means, it allows this is my road surface, this is my road surface, it allows impact load at certain interval of time; that means whatever load coming here, then after certain interval it applies also same, then same. This is called kind of repeated loading applied due to traffic conditions. So, what will happen once the load has been applied? It impacts the load once vehicle passes, suppose the vehicle passes here, vehicle passes here so, what happen? It apply load, then once vehicle goes, then again it will kind of think, once vehicle passes it apply load, once vehicle go this will again what will happen? There will be rebound; then again vehicle will be there, then again it will be there, then once vehicle will go, there is in the road there is no load, once the vehicle passes, there is no load; so what happen in the soil? Again it will be rebound, then another part of this vehicle passes again it will be go means then again one vehicle passes, then this is rebound. This kind of particularly particularly this is loading and unloading means, how much deflection accumulated both

elastic as well as permanent deflection, you can find it out; and it has a meaningful means in this road base, if there is a repeated loading by means of vehicles, what is that elastic deformation occur? What is your permanent deflection means, after this elastic deflection, what is the permanent deflection occurs that is required this permanent deflection is required for design of this pavement and road.

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Now if you look at here so this is my permanent deflection, accumulated permanent deflection, this much is your permanent deflection. So this permanent deflection you have to identify, by means of repeated loading; this deflection whatever achieved by vehicle this permanent deflection it will not bounce back, it will there in this road surface or pavement. So this, this is all about this cyclic plate load test.

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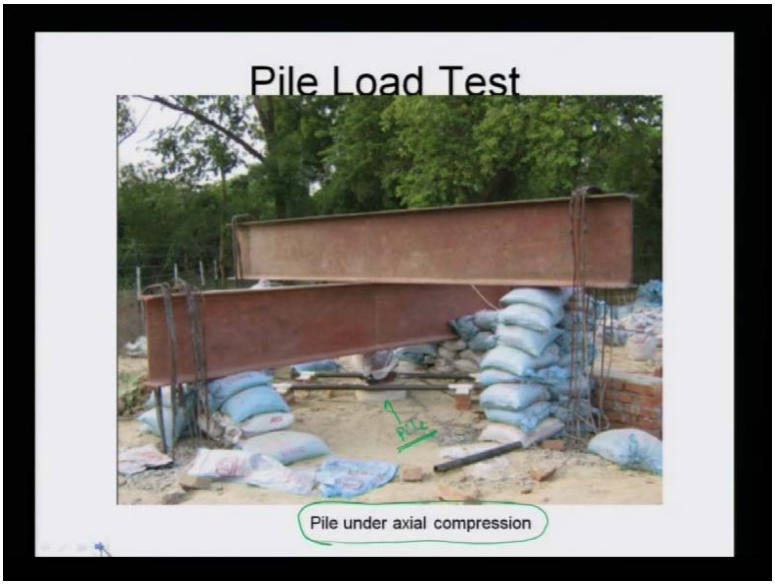

Now go to the next phase, this is interesting, this is another, it is called pile load test. Pile load test has been performed in the field to find it out pile capacity; this is one this test has been conducted in our geotechnical engineering laboratory IIT, Kanpur, this is pile under axial compression. If look at this figure, my pile is here, what are these piles? Now before I describing this completely pile load test under axial compression, then what are these piles, you see.

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This is typical of a pile of diameter 0.4 meter, and length has been taken as 4. So L by d is equal to 10, L by d - is equal to l by d length to diameter is equal to 10. So, pile material has been constructed with M-20 grade of concrete and steel is Fe-415 grade of steel. So, the construction technique is it is it has been done by means of cast insitu bored piles, by means of cast insitu bored piles. If you look at here, the bore hole has been made by means of hand auguring, with this helical blades, these are helical blades, I will also show later on how the auguring has been done. Once this auguring has been done, bore hole has been done, then this pile material, pile diameter with this casings has been prepared outside by means of a circular of pile size of L by d 10 and diameter is equal to 0.4 meter and these are my longitudinal bar, these are the shear bars or transfers bars, it has been provided outside.

Then once the bore hole has been made, inside this bore hole the entire casing consist of steel longitudinal bar as well circular bar and making a diameter, this is this is my diameter of 0.4 meter 0.4 meter, it has been pushed inside this ground, it has been pushed inside the ground; once it has been pushed inside the ground, then what will happen? You prepare concrete, you prepare concrete M-20 grade of concrete you prepare, then this concrete you pour inside, so that what will happen once you pour inside, this will become reinforce concrete of pile.

So, why it is called cast insitu bored pile? So, there are three kinds of piles; one is driven pile, one is cast insitu, bored pile, means there are different classification; if I if I make it into two parts, one is cast insitu bored pile, other is your driven pile. In case of cast insitu bored pile, the meaning of cast insitu means, the casting has been done itself in the field, the casting has been done, casting of the pile has been done itself in the site. If you look at here in the site, boring has been done, after boring has been made in site itself, entire preparation of this casting of the pile has been done. Then that is why it is called cast insitu bored pile.

Then casting of pile has been done; this pile has been inserted, placed inside the bore in the field, there is nothing; you bring it outside. What happen in case of in case of driven piles, you bring pile outside like concrete pile, you prepare somewhere else and bring it back from outside. So again in the field you drive it. The moment I say it is cast insitu bored pile that means everything has been done in the field; casting, boring, boring casting, and placing pile inside the bore hole, and placing this concrete inside this bore hole, everything has been done, everything has been done in the field. So sometimes we prepare also sometimes people place also strain gauges inside this pile.

So this is one of the part of the research, so strain gauges along the pile, along the length of the pile, suppose this is my length of the pile, length of the pile, sometimes we provide strain gauges along the length of the pile, so that stress transfer as well as strain particularly, strain transfer along the length can be measured. Once you once you strain transfer you measured, then you can say that the load what is the coming to the pile, how it has been transferred to the ground surface or transferred to the pile as well as soil pile soil interface, how it has been transferred?

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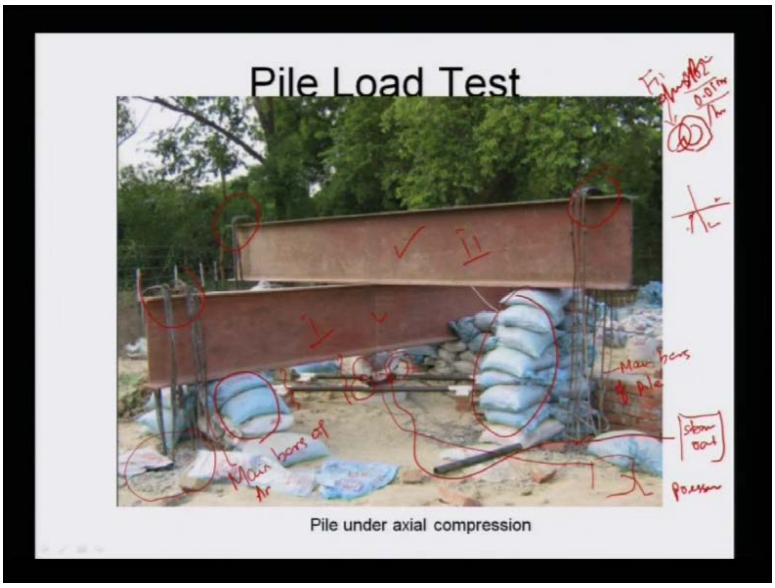

Now, this is case one pile load test in case of pure compression. So, what happen? Initially pile has been means cast insitu bored pile has been made; so here cast insitu bored pile has been made. Then with this, these are four anchor piles; if I draw how this phenomenon, how suppose this is my pile has been constructed inside the ground. So what happen? There are reaction beams opposite to each other. So it has been the reaction has been taken by means of anchor piles.

So, if you look at here in the figure clearly, this is one anchor pile, this is another pile, opposite to that this is one anchor pile, and somewhere else there is anchor pile. So, what happen? First these are called girders; so what happen? Initially one girder has been placed over the pile by the means of hydraulic jack; if you look here, this is my hydraulic jack; this is the hydraulic hydraulic jack. So what will happen? So, above the pile head, prepare a pile head, this is the pile head, prepare a pile head; then after the pile head above the pile head, place one hydraulic jack.

Then in the pile head, if you mark it, there are two dial gauges opposite to this pile head. It is diametrically opposite means, if this is my diameter, this is opposite one dial gauge here, so that you can measure the displacement this after placing this hydraulic jack after putting hydraulic jack in the pile head and place one girder, this is one girder. So, now after placing hydraulic jack, place two dial gauges at the opposite, diametrically

opposite, so that both the ends you can find it out both how the displacement or settlement vary.

Then after placing it, you place, place one girder here, this can dial gauge, you can place it place it after placing all the girders, because initial phase it will settle because of self-weight of girder. Initially what happen? You place this one girder, then this girder, first this is girder one; and this is girder two; this first girder has been connected connected by means of by means of bars, reinforcing bars of the anchor pile. If you look at this, this is my anchor pile; with this anchor pile, whatever the bars, these are main longitudinal bars, main bars of anchor pile; so these main bars of anchor pile has been tied in girder one; and at the opposite also it has been tied with girder two.

Once one girder has been placed, so initially what happen? Before placing after placing in the pile head, there will be gap from the ground, it has been it has been placed, because this height is a gap from the ground; so it may fall. To make it symmetry, some sand bags has been provided, so it makes symmetry, it place in horizontally. Then what will happen after placing one girder, you can place second girder, so second girder. So, basic principle is whatever load coming to the pile, so it will taken by girder one as well as girder two by means of pile anchors by four four parts. So after placing this, same way you can place the girder, here also the main reinforcement, main bars main bars of pile tied with this a girder. So, this girder has been crossed 90 degree to each other it has been placed, and making symmetry also second girder some sand bags sand bags has been placed both the ends. This is stage two.

After you provide this, then stage three, you place your you wait for some time; so that whatever displacement has been achieved by self weight of girder, you can you can leave it. This is as a (( )) then after that you place your you take the reading from the dial gauges by means of hydraulic jack. So, in this hydraulic jack, what will happen? There is this hydraulic jack is there, it has been connected somewhere else and here also, there are some wires are coming, where you can measure also strain gauges, strain rate you can measure, here you can apply pressure to this, apply pressure to this hydraulic jacks. So, you apply the pressure intensity, you apply pressure intensity, suppose you applied 10 ton, 10 kg per cm square. So, what will happen? It will you try to make this, once you apply pressure to this girder, it will try to make uplift, make up to the girder. So, this girder will go up, and it will rest, rest against this anchors pile head anchors; so each

action has equal and opposite reaction as I said, once it rest against the pile anchor, so it will apply load indirectly downward, so the pile will settle downward.

Then each load increment you apply and weight for this, how much is your continuously you apply this load 10 ton per meter square or 10 kg per cm square it will be applied, you maintain that pressure, so that you observe this how much is your dial reading. So initially dial reading is you are continuously taking the dial reading; after certain time you will find that dial reading will be like be 0.02 or may be 0.01 mm per hour. Remember the moment you start this pile load test, you cannot stop any any any time in between, it will be continuous process, it will be continuous process.

So that means once you applied suppose say, you applied like 10 ton per meter square or 10 kg per centimeter square continuously you apply pressure through this hydraulic jack. So 10 kg per cm square or 10 ton per meter square, if you apply the pressure, you measure this displacement by means of dial gauge. So, displacement is increasing, increasing, increasing, you just record it, record it and wait. Once the displacement will reach 0.02 or 0.01 mm per hour, you stop at that point, and that is your final displacement for your load intensity say 10 kg per cm square or 10 ton per meter square. Then you apply your next load intensity, like this you continue, continue, continue till pile fails or as per IS standard whatever you will get it, up to that you can go, so that you can plot load verses displacement.

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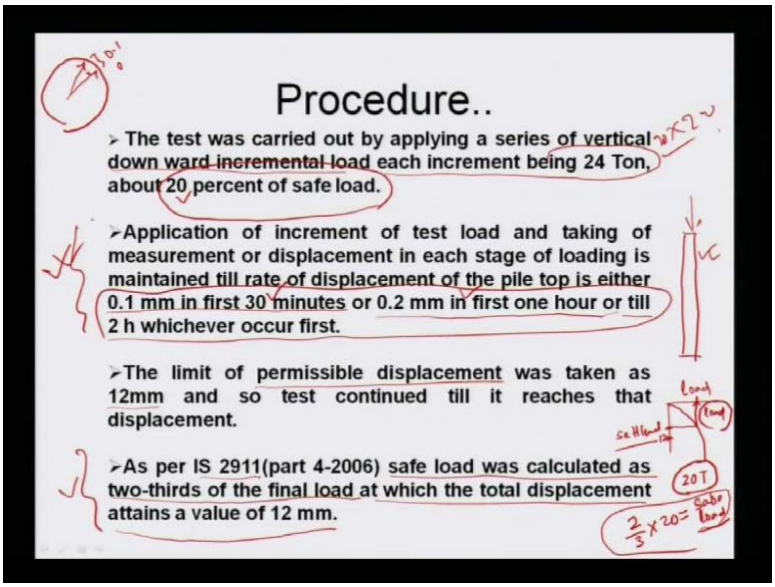

Now, you see this is the procedure, just it is written. The test was carried out by applying series of vertical downward increment load; each increment being, in this case 24 ton, in this case whatever I have shown about your geotechnical laboratory test; it is of 20 percent of safe load that means before starting the test, you take the pile, and find it out theoretically, what is the bearing capacity of pile, then from this bearing capacity theoretically you can find out what is the safe load of this pile. Once you get this safe load theoretically, then each load increment should be 20 percent; that means suppose you are taking 200, so it will be 20 percent first start, you can start with this 40 ton or 40 ton or 40 gram per kg per cm square. So, 20 percentage of safe load is every time you have to increase. So, this is where how it has come; it has come from theoretical calculation.

Then after application of increment of test load and taking measurement of displacement in each stage of loading is maintained; as I said earlier till rate of displacement of pile top is either you see, 0.1 mm in first 30 minutes or 0.2 mm in first 1 hour or till 2 hour, which occurs first? Look at the sentence, which comes first? That means how do you stop, how do you… From where you can decide, next increment of load can be applied? So, you can decide based on that, first one is 0.1 mm in first 30 minute; are you achieving first 30 minute? Suppose this is my dial gauge, so within first 30 minute, are you achieving the displacement of 0.1 mm? Are you achieving? Yes. Then are you if you are not achieving, you wait; whether you are achieving 0.2 mm in first 1 hour or you wait till 2 hour; which ever come first? That means if this is coming first, then you can stop; if this coming first, then you can stop. This has the meaning; that is the stop point or maybe that point, where you can apply next increment of load. Then the limit permissible displacement was taken as 12 mm, and so the test continues till it reaches that displacement.

So permissible displacement as per IS code, you can go upto what displacement? You can go up to 12 mm displacement. So that you can before 12 mm displacement, you can get the failure or if you are not getting this failure, then you can go up to 12 mm of displacement; you see it is written very clearly as per IS-Indian Standard 2911 part 4-2006 safe load was calculated as two-third of final load, at which total displacement attains a value of 12 mm.

If there is a pile load test, as for IS code it says from this pile load test, safe load was calculated as two-third two third of final load at which total displacement attains a value of 12 mm. If I plot load verses settlement, load verses settlement, whatever I got it, first increment, second increment, third increment or fourth increment, whatever I got it, if I plot load verses settlement; that means it says as per IS 2911, safe load was calculated as two-third of final load, at which total displacement attains a value of 12 mm.

First take 12 mm of displacement, then with correspond to 12 mm of displacement, what is that load? Say 12 mm of displacement, say load is equal to say load is equal to say 20 ton, as per IS code two-third of final load, at which total displacement attains a value of 12 mm that means I will go two-third of 20, which is equal to your safe load. So that means you go up to settlement, you go up to settlement, once it you attain that settlement either the pile fails or if it does not fail, then what will happen? You wait up to the settlement of 12 mm; once this settlement 12 mm has been achieved, 12 mm has been achieved, the corresponding load will be taken, and two-third of this load, two-third of this load is taken as safe load of this pile.

I hope now, this is clear. These are the two major parts; one is your one is your where you stop, at what point increment of load, second increment, next increment of load you are going to start or where you will take the displacement reading. It says like as I said once I am repeating 0.1 mm in first 30 minutes or 0.2 mm in first hour, whichever comes first; that means which one comes, you can see which one from this dial gauge displacement that you take it. Other is your the limit permissible displacement was taken as 12 mm; so why the 12 mm has been taken? It is based on that as per IS 2911 safe load was calculated as two-third of final load, at which total displacement attains the value of 12 mm; that means up to 12 mm what is the load coming that load two-third you can consider, so that two third is your safe load.

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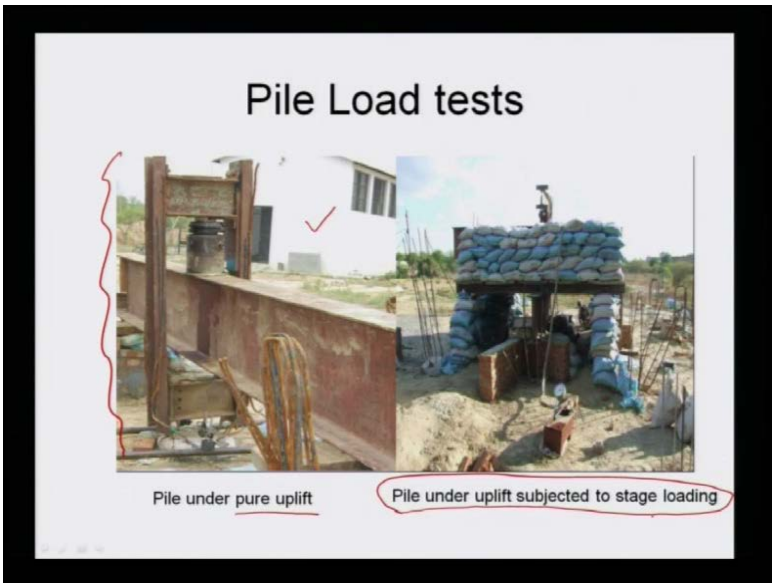

This is another typical arrangement that arrangement was pile load test with compressive load. This is typical arrangement; one is your pile load test to get, what is its tensile capacity or uplift capacity. This is pile under simultaneous uplift as well as compression capacity, how this test can be performed. If you look at here, this is specially designed at IIT Kanpur, in this (( )), so that we can measure this load versus… We can measure this piles under means uplift capacity of piles. Here also this pile load has been measured with the help of static compressive load or stage loading. I will stop it here with the next (( )).