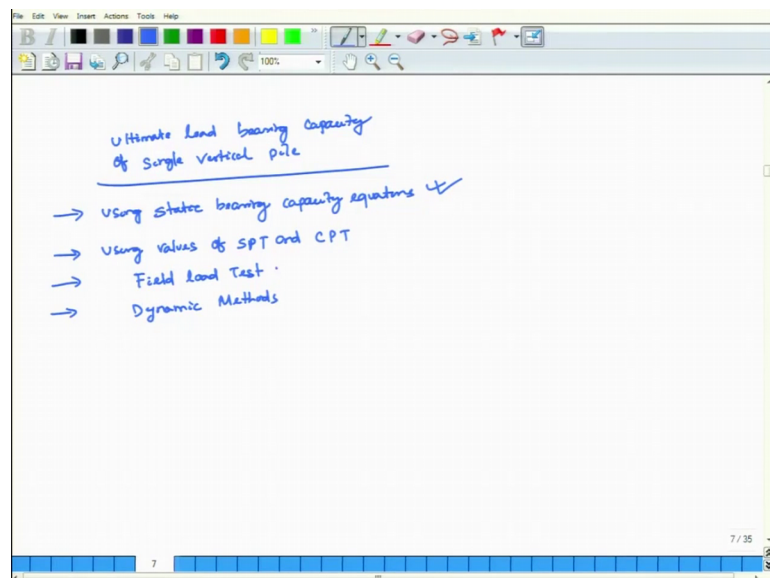


**Foundation Design**  
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**Lecture – 20B**  
**Deep Foundation - Part 5**

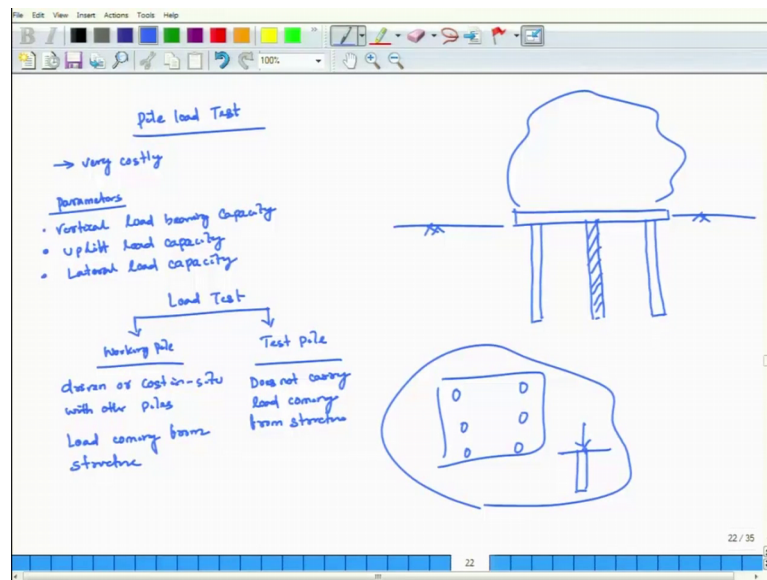
I have covered to find it out pile capacity by means of dynamic pile driving formula, there are two formulas one is Hiley's formula and limitations also I have discussed, other is Engineering News-Record formula.

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Now if I come back to the original one, these are the four methods to find it out ultimate bearing capacity by static equations, by dynamic methods now I am discussing field load test pile load test.

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So, it is most acceptable method to determine load carrying capacity of pile, only limitation is its very costly. So, from the pile load test or field pile load test, we can find it out vertical load bearing capacity, uplift load capacity then lateral load capacity.

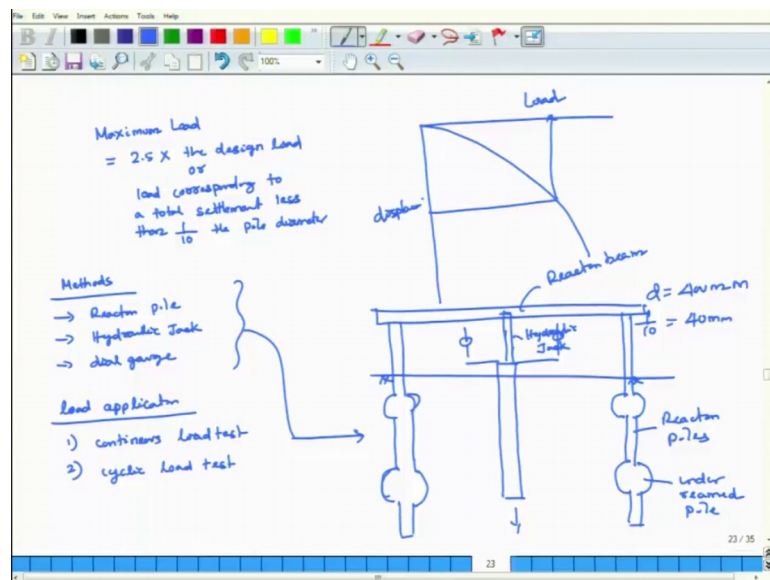
Before I start this discussions, load test generally carried out pile load test generally carried out by means of load test, generally carried out either a working pile or a test pile. Working pile is what is working pile and what is test pile, in working pile; pile is either driven or cast in c 2 along with the other piles. So, it has been installed while in working pile what is it mean. If this is a group of pile, work in pile means generally what happens one of the pile has been instrument and it will be connected, and in the foundations it is there throughout the life time, then superstructure has been built superstructures has been built and every time while the building has been constructed, even if at the end of this constructions.

You will get the response of one of the pile what is the load distribution what is the load versus displacement, how much is your load share, everything you will get it, suppose middle pile is I can say it is a working pile. But what will happen in a test pile, test pile is a separate suppose there is a this is the plan this is a building plan area, where this building has to be constructed and it multi storey building has to be constructed and it has been advised to have a pile load capacity, then in this case to have a pile load capacity what supposed to be done, if it is a test pile in this area only initially a single

pile load test has been carried out, one single pile load test been had been carried out from their ultimate load capacity has been calculated. Once you know the ultimate load capacity and settlement criteria that has to be used of construction of other piles actual foundations.

So, this is the difference test pile which is at does not carry the load coming from the structure. It carry load coming from structure whereas, test pile does not carry load coming from structure.

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So, what is the maximum load you can take it? Maximum load is your 2.5 times they design load or the load imposed must be such that to give a total settlement less than load corresponding to a total settlement less than one tenth the pile diameter.

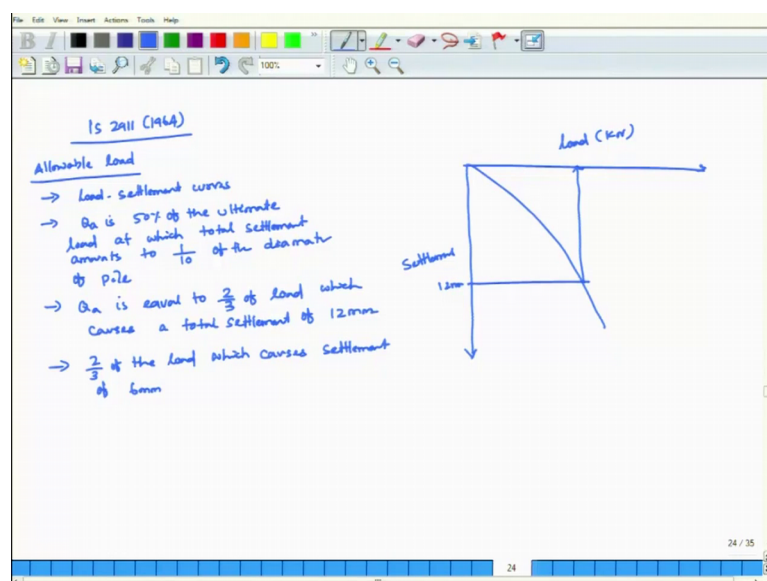
So, maximum load you can take it 2.5 times more the design load, or the load imposed must be such that to give a total settlement less than one tenth of pile diameter o what is it mean? You are applying this is your displacement. So, 25 of the design load initially theoretically you find it out what is the design load, then its 2.5 times more you can go up to that design load. So, for design load is tend on. So, 2.5 turn additionally are it then that should be or you can go to the load impose such that suppose the diameter of the pile is equal to 400 mm. So, it will be one tenth of pile diameter; that means, one tenth is equal to 40 mm. Up to 40 mm corresponding to that load up to that load; that means, you

apply load you are supposed to get are is a 40 mm then methods carrying out vertical pile load test.

So, it has to be arranged there is a reaction pile then hydraulic jack you up to hydraulic jack to apply load, then there is dial gauge, then load applications. Load application it will be two types first one is your continuous load test, second one is your cyclic load test, first one is your continuous load test, second one is your cyclic load test. If I come back to the method, how it looks like? This is my ground surface this is the main pile and this main pile connected by means of hydraulic jack, then there are two dial gauges at the end to measure the displacement, and this reaction beam the reaction beam this is my reaction beam, these are all reaction piles these are all wonder in piled. So, the moment you apply hydraulic jack load applied.

So, it will go up and rest in your reaction beam be with. The reaction beam is fixed against your reaction piles wondering pile. So, every reaction has equal and opposite reaction. So, then load will be applied here, then it will try to push this pile down what then at the same time you can measure displacements by means of dial gauges. So, two ways of applications one is your continuous load test static, second one is your that is your cyclic load test cyclic load test particularly you up to go cyclically loading, each load you have to go for loading, then unloading, then loading, then unloading, then it this way it will continue.

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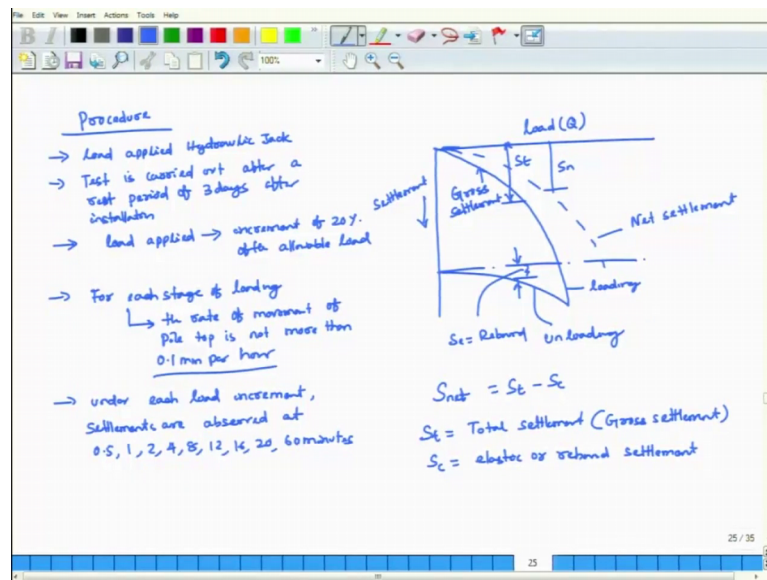
So, what is your allow load as for your I s 2911 1964 from pile load test, as per your I s 2911 1964 what is your allowable load from pile load test.

You can get it from load settlement curves number one, then number 2 if  $Q_a$  is 50 percent of the ultimate load, at which total settlement amounts to one tenth of the diameter of pile, then second one is your  $Q_a$  is equal to two third of load which causes a total settlement of 12 mm, then forth third criteria is two third of the load which causes settlement of 6 mm.

So, as for I s 2911 1964 there are three criteria's. If you have a pile load test from they are you are supposed to get it load versus settlement curves first one is your allowable load where 50 percent of ultimate load at which total settlement amounts to one tenth of the diameter of the pile corresponding to a one tenth diameter of the pile. So, you are supposed to get 50 percent  $Q_a$  cure is the 50 percent of ultimate load at the one tenth of diameter pile that  $Q_a$  is your 50 percent, second one is  $Q_a$  equal to two third of load allowable load is equal to two third of the load applied, which causes a total settlement of 12 mm; that means, when there is a 12 mm of settlement corresponding 12 mm on settlement. Suppose this is my loads kilo newtons and settlement load settlement curves suppose I am getting from pile load test.

So, total settlement of 12 mm, suppose this is my 12 mm with respect to that whatever I am supposed to get it. So, two third of this is your key way, last one is your two third of the load which causes settlement of your 6 mm. These are all your bureau of Indian standard as per the bureau of Indian standard code, then what is the procedure, then come back to the procedure what is the procedure.

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So, load applied by means of by means of hydraulic jack. So, test is carried out after rest period three days, after installation. Load applied in equal increment about of 20 percent, load applied increment of 20 percent of the allowable load per each stage of loading it has to be maintained.

Till the rate of measurement of pile cap is not more than rate of movement of the rate of moment of pile cap or pile top is not more than 0.1 mm per hour. Under each load increment settlement are observed at observed at 0.5 1, 2, 4, 12, 16, 20 and 60 minutes. Load application the procedure is load applied through the hydraulic jack once you install the pile, pile can be done by means of cast in situ or by means of bored piles once you install the pile inside the ground you leave this pile for three days for the reequip type. After three days you go for pile load test then whatever the theoretical load you applied means you are suppose to get your theoretically allowable load by means of this formulas, then suppose you decide this is my theoritically allowable load, then divide into taking that load into considerations for pile load test.

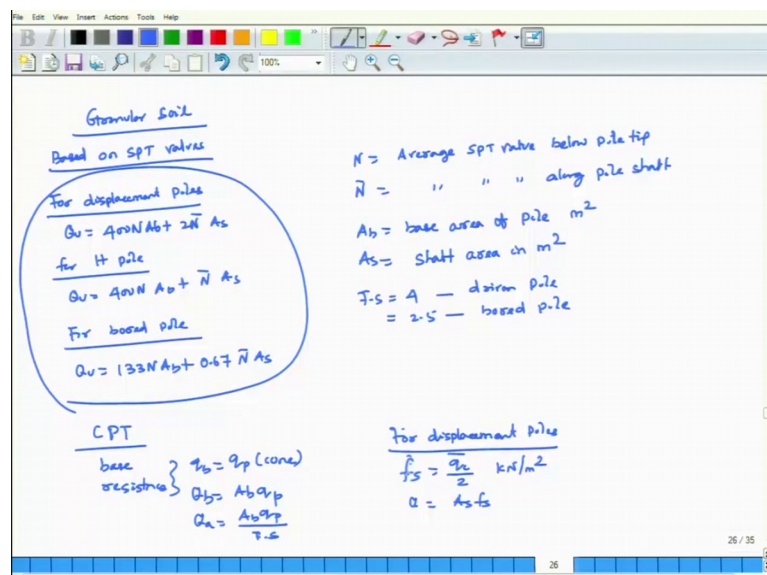
Twenty percent of that load every time has to be applying; that means, in increment of 20 percent of the allowable load. For each test loading means how to apply next load increment? You have to wait till you are getting displacement or pile top moment 0.1 mm per hour within an hour it is moving either 0.1 mm or less then that. Then you stop that then you apply for next loading increment under each load increment, you note the

settlement 0.5 second 0.5 minute 1 minute 2 minute 4 minute 8 minute 12 minute 16 minute 20 minute and 60 minutes once it is 60 minute; that means, one hour then you go go for 2 hour, 4 hour, 8 hour then 20 four hours.

Now, come to this cyclic this is for a static come to the cyclic case, this is my load Q this is the settlement this is loading, this is unloading this is your S e is equal to rebound, this part is your net settlement, this is your gross settlement this is your S t and net settlement this is your S n. So, if I write net settlement S e is a rebound look at here, each load intensity applied unloading then again loading unloading these way cyclic load has to be carried out then S net, S net is equal to S t minus S e. S t is your total settlement or gross settlement S c is your elastic settlement S c is equal to elastic or rebound settlement.

So; that means, once we are unloading how much is rebound? Particularly what the cyclic load test has to been carried out you have to find it out what is your elastic settlement what is your permanent or plastic deformations once you apply the load then you unload pile rebound it back; that means, this is your rebound then once you apply again loading unloading then permanent depression will come into picture this is about the pile load test from the pile load test I am supposed to get it load carrying capacity.

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Now, if I come back to here first one we have finished static, bearing capacity equation dynamic method you have finished pile load test we have finished now using the value of

SPT and CPT bearing capacity of piles in granular soil based on your SPT value granular soil based on SPT values.

For displacement piles  $Q_u$  is equal to  $f_{400} N A_0$  plus  $2N \bar{A}_s$  for H pile  $Q_u$  is equal to  $400 N A_b$  area of base plus  $N \bar{A}_s$  for bored pile  $Q_u$  is equal to  $133 n$  area of base plus  $0.67 N$  area.  $N$  is your average SPT value below pile tip, below pile tip then  $N \bar{A}_s$  is your average SPT value along pile shaft.  $A_b$  base area of piles meter square  $A_s$  is equal to shaft area in meter square.

Generally factor of safety of 4 for driven pile has been used and 2.5 for bored pile. Then based on CPT this is what based on SPT, now based on CPT cone penetration test. So, base resistance  $q_b$  is equal to  $q_p$  cone and capital  $Q_b$  is equal to  $A_b q_b$   $Q_a$  is equal to  $A_b q_p$  divided by factor of safety for displacement piles,  $f_{sp}$  is equal to  $q_c \bar{A}_s$  2 kilo newton per meter square sub resistance then  $q$  is equal to  $A_s f_s$ .

So, this is basically SPT and CPT are test are particularly cohesion less soils. So, based on SPT for displacement pile s pile and bored pile based on CPT base registration how to find it out for displacement pile what are the things. So, this is about your first part which I have covered ultimate load carrying capacity of bearing capacity of single vertical pile, considering startic bearing capacity considering using SPT and CPT using pile load test using dynamic methods. I will stop it here next class, I will start group action of the piles.

Thank you.