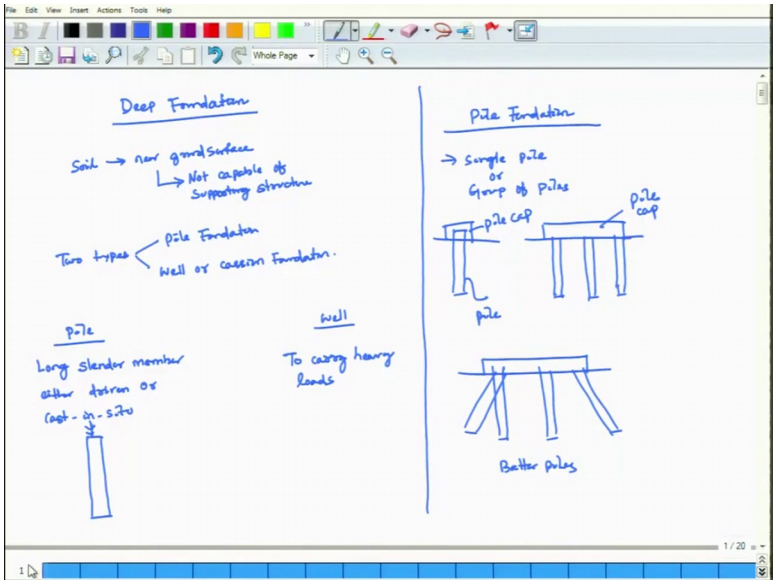
Foundation Design
Prof. Nihar Ranjan Patra
Department of Civil Engineering
Indian Institute of Technology, Kanpur

Lecture - 18C
Deep Foundation- Part 2

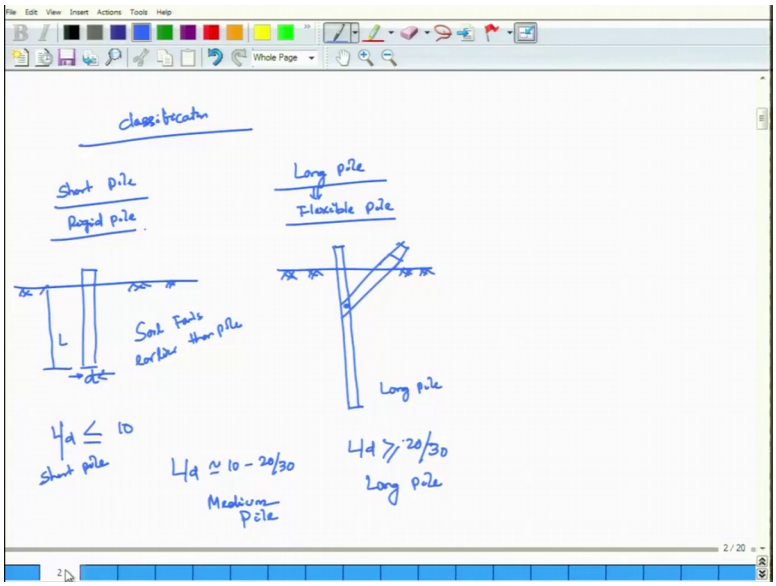
Last class I have started deep foundations, with this 2 types of deep foundation.

(Refer Slide Time: 00:17)



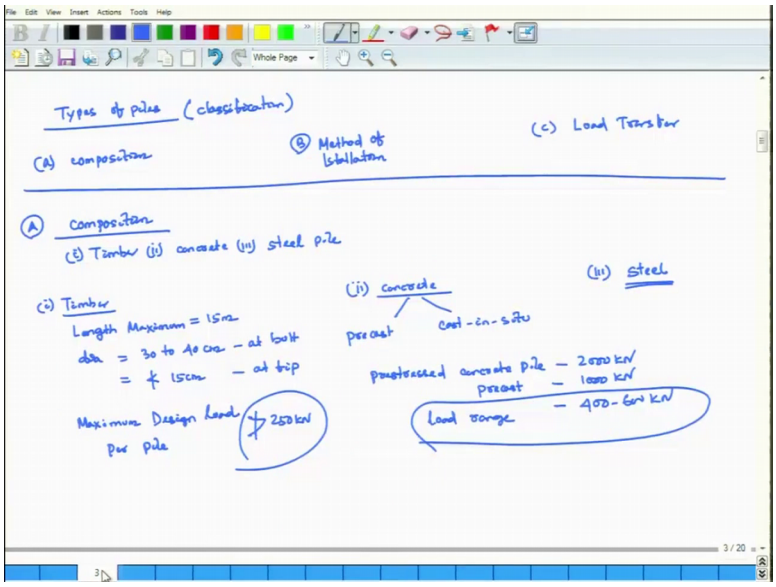
One is pile and well foundations. And pile foundation I discussed. It may be provided single group of pile or better pile.

(Refer Slide Time: 00:29)



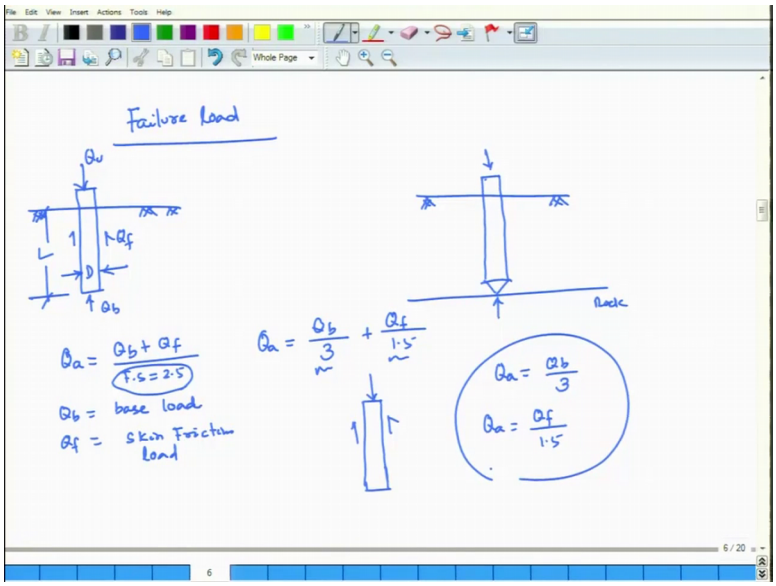
Then classification of piles also I have explained short, rigid, long, flexible.

(Refer Slide Time: 00:37)



Then also is started I have finished types of piles, classification based on composition, method of installation and low transfer. Then let us start with this now Failure load.

(Refer Slide Time: 00:49)



In failure load let us start with this. This is your Qu. This is your embedded length, and this is your diameter D. And one is your point bearing, other is your sub friction.

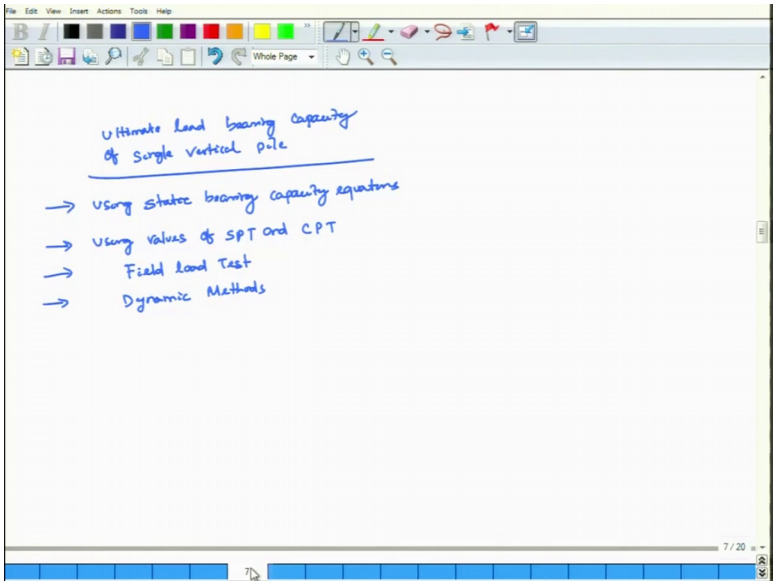
So, if I write it failure load Q a, Q allowable, Q a is equal to Q b plus Q f by factor of safety for pile foundation generally it is provided 2.5. So, Q b is your base load and Q f is your skin in friction, skin friction load. So, in case of the values of Q b and Q f can be Q allowable used. So, if I go by independently if I go by independently, you can write it Q a is equal to Q b by a factor of safety generally 3 plus Q f by is your factor of safety generally 1.5. If you are going by this is a pile, in this pile we are considered both end bearing as well as frictions.

If only it is end bearing pile. For example, let us say this is the case as I have explained earlier, there is a load coming here. And here it is here it is So, Q a is equal to Q b by 3 and Q f by 1.5. So, these are the 2 factor of safety independently if you are taking both friction as well as end bearing pile then in that case total factor of safety will be 2.5. Now in this case in this case if there is a case here than in this case there is a rock layer, what will happen? Load will be transferred by means of end bearing. Once it will be end bearing then in that case Q a will be Q b by factor of safety of 3. Now other case other case where load has been transferred by means of frictional resistance.

In this case Q a is equal to frictional resistance by 1.5. So, that is why this is your allowable load. So now, method of finding out what are the different methods to find it

out ultimate load bearing capacity of a single vertical pile; ultimate load bearing capacity of single vertical pile.

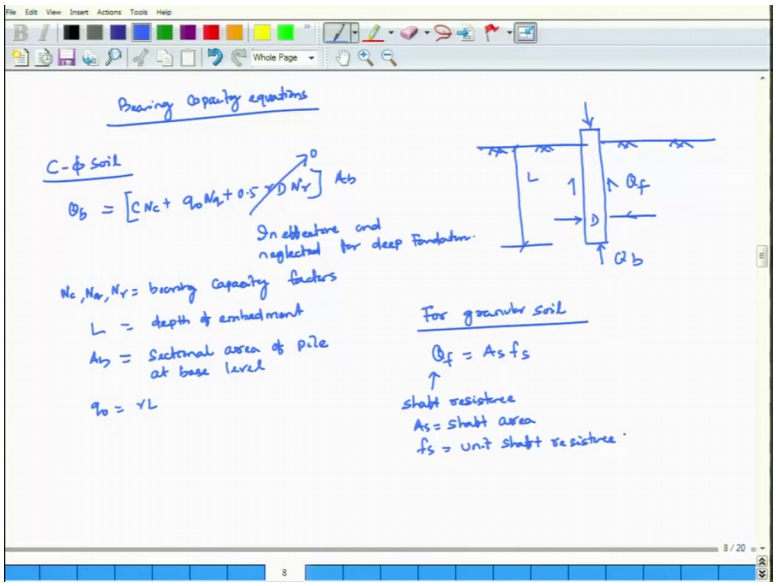
(Refer Slide Time: 04:04)



So, there are different ways. So, there are different methods, first one is your using static bearing capacity equations particularly bearing capacity equations, using static bearing capacity equations. Then use of values of or using values of SPT standard penetration test, and CPT. Cone penetration test, then by means of field load tests, and by means of your dynamic methods. What I have discussed earlier if this is allowable load, theoretically you have to find it out what is the end bearing capacity, what is the friction capacity.

So, to get that ultimate load bearing capacity of single vertical pile, first one is your using static bearing capacity equations using values of SPT and CPT. SPT is your standard penetration test and CPT is your cone penetration test. And third is your field load test fourth is your dynamic methods. Now let us consider first let me start with this using bearing capacity equations, bearing capacity questions first one.

(Refer Slide Time: 06:22)



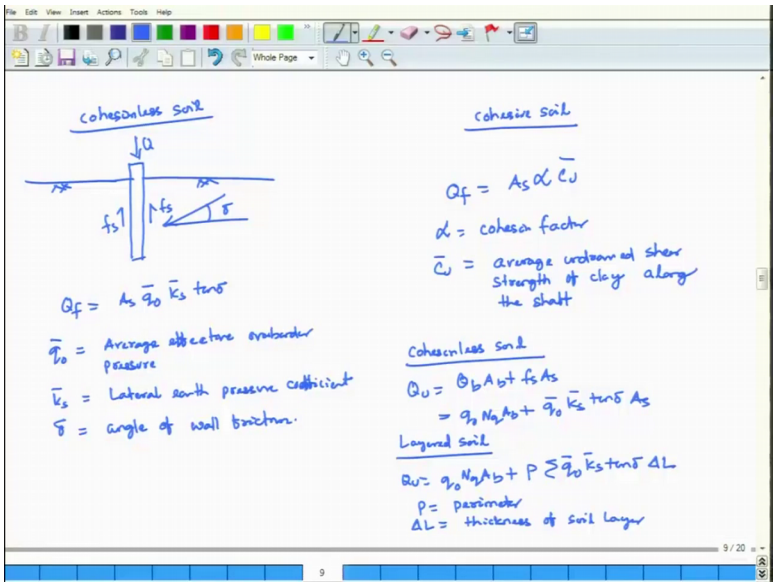
By using your bearing capacity equations; so for c phi soil, for c phi soil Q b, because if this is my pile, this is your load this will be your frictional resistance Q f and this is your Q b base resistance.

So, Q b if I write it there is again bearing capacity equations, it will be c N c plus Q 0 N q plus 0.5 gamma D into n gamma; gamma D into n gamma D is your capital D is your diameter of phi capital D is your diameter of phi, into because this is a capital Q, then area of your base area of your base. So, this generally has been neglected for deep foundations, it is ineffective and neglected for deep foundation, neglected for deep foundation.

So, N c N q and n gamma N c N q and n gamma are bearing capacity bearing capacity factors. And if I write it, this is my L is your embedded length L is your embedded length or depth of embedment. A b is your sectional area of phi at base level base level. And Q 0 is equal to Q 0 is equal to gamma into L gamma into L. Gamma is equal to effective unit weight of the soil. So, let me start with this for this Q f for granular soil, for granular soil Q f is equal to A s into f s. So, Q f is your shaft resistance A s is your shaft area f s is your unit shaft resistance.

So, for cohesion less soil I am going to next page.

(Refer Slide Time: 10:34)



For cohesion less soil, for cohesion less soil if I write it, let is take it a pile here. Then this is your f s, this is your Q, which will be acted upon by this is your delta. If I write if I write Q f Q f is equal to A s Q 0 prime K s prime tan delta. So, in this case in this case K s prime Q 0 prime is your effective overburden. So, this will be your Q 0 this is your f s and this is your delta. And K s is your lateral earth pressure coefficient let me write it, Q 0 prime means average effective overburden pressure.

Average effective overburden pressure K s is your lateral earth pressure coefficient, lateral earth pressure coefficient. Then delta is your angle of wall friction, similarly for cohesive soil, for cohesive soil cohesive soil Q f is equal to Q f is equal to A s alpha C o. Bar alpha is equal to this is your cohesion factor, and C u bar is your C u bar is your average undrained shear strength of clay, average undrained shear strength of clay along the shaft along the shaft.

So, let me write it let me write it for cohesion less soil all total how it is coming. So, total ultimate bearing capacity of single pile is your Q b into A b plus f s into A s which is equal to Q 0 N q A b plus Q 0 prime K s prime tan delta A s. For layer soil what will happen for layer soil cohesion less soil, layer soil Qu is equal to Q 0 N q A b plus p is equal to perimeter summation of Q 0 prime K s prime tan delta into delta l. So, p is equal to perimeter, delta is equal to delta L is equal to thickness of soil layer.

So, all total if I start with this for particularly first one, this is your using static bearing capacity equation, then for see if I soil if I am considering your tera zaghi is bearing capacity that is your c N c Q 0 and Q plus 0.5 gamma D n gamma into A b. So, that is your resistance of the base for deep foundations, deep foundations 0.5 gamma D and gamma has been neglected to 0. A b is your sectional area of pile at base level, Q 0 is equal to gamma L, L is equal to depth of amendment. For granular soil Q f is equal to A s into f s.

Now, for base resist for cohesion less soil frictional resistance is your A s Q 0 prime K s prime tan delta. Q 0 prime is your average effective over burden pressure along the shaft length. K s prime is your lateral earth pressure coefficient. Delta is your angle of wall friction. For cohesive soil Q f is equal to A s alpha C u bar. Alpha is equal to cohesion factor. C u bar is equal to average undrained shear strength of clay along this shaft. Now if I am writing altogether cohesion less soils.

So, Qu is equal to Q b A b Q b A b plus f s A s. So, Q b A b is equal to Q b A b plus f s, says if I write it Q 0 N q into A b plus Q 0 bar K s bar tan delta into A s for layer soil layer soil the Q 0 N q A b this is your base resistance. This will be fixed for particular layer for other part of this shaft. It is a summation of Q 0 prime K s prime tan delta into delta L delta is your thickness of yourself soil layer into is your perimeter.

So, next part is your how do I calculate, how do I calculate base resistance and what are the different factors affecting, I think I will I will stop it here. So, next class I will do other part.