Foundation Design
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Lecture – 5A
Bearing Capacity of Shallow Foundation- Part 1

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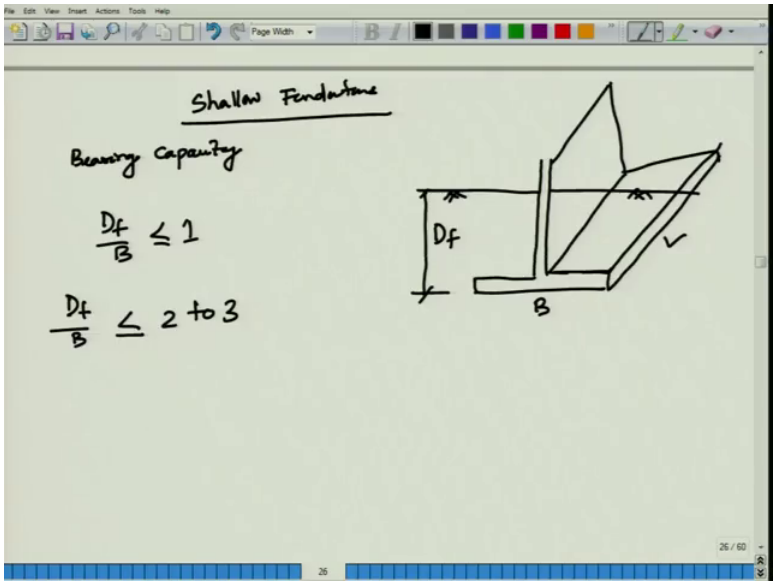

So, let us start with ultimate bearing capacity and the shallow foundations. I can write it shallow foundations then your bearing capacity, this is B, this part is your L and this is your D f - depth of the foundations, as per the Terzaghi if D f by B is less than equal to 1 depth of the foundation by your width of the foundation is less than 1 then you can say it is shallow foundations. A later some researches after be research it has been category can changed D f by B less than equal to 2 to 3 is called you are shallow foundations. If I divide into shallow foundation, and deep foundations what is the criteria if the D f by depth of you are foundation by is your width of footing is less than equal to 2 to 3 then you can categorized as shallow foundations, and if it is not then it will be deep foundations.

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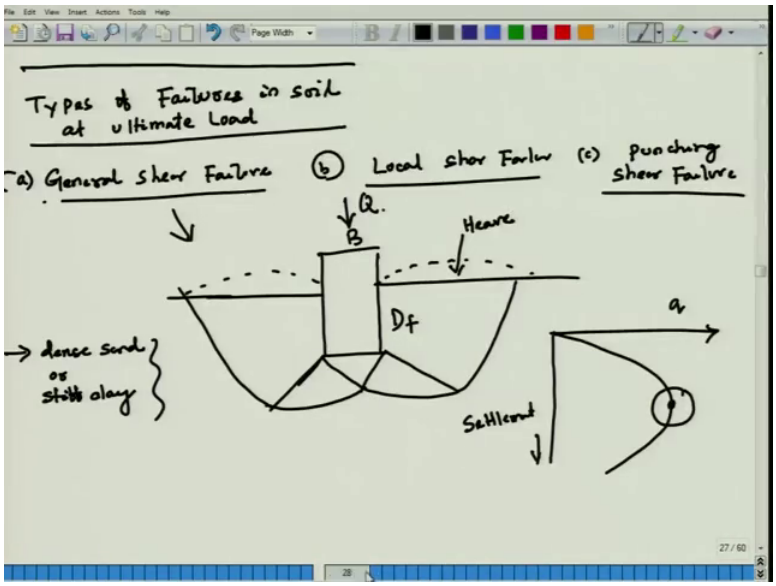

Now, types of failures in soil at ultimate load - types of failures in soil at ultimate load. If I can put it in to 3 categorizes - one is a general shear failure, b - local shear failure and c is your punching shear failure. So, what is your general shear failure, local shear failure and punching shear failure? I have to draw just from the general shear failure a bigger one; I am talking about general shear failure depth of your foundations. So, particularly general shear failure foundation supported on, particularly on a means foundation supported by dense sand, dense sand or stiff clay in that case it is expected that suppose to get general shear failure and in general shear failure if I draw load versus or load intensity q versus your settlement, settlement, definitely will get a peak. Distinguish failure mode were suppose to get it in case of your general shear failure.

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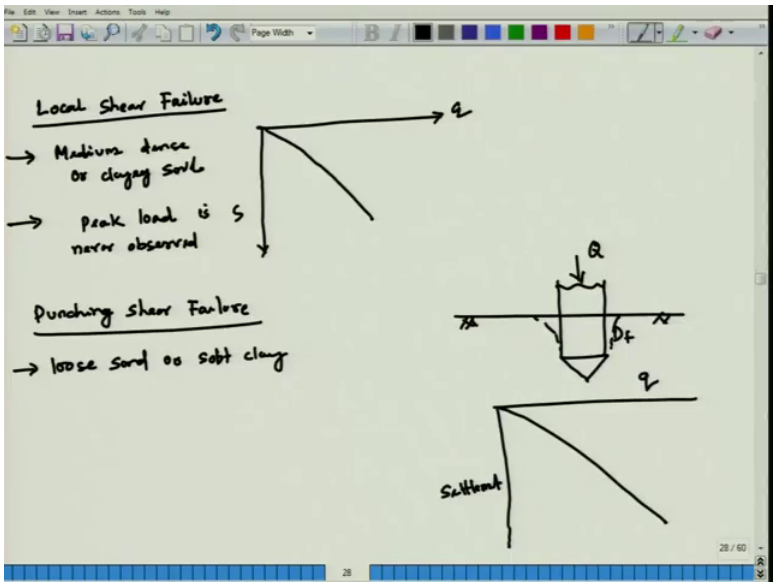

So, now come to your local shear. In local shear failure, generally if foundation is supported by medium dense or clay soil in that case we can expect local shear failure. So, in that case peak load is never observed. So, if I draw load versus a load intensity q versus settlement and suppose to get kind of this type of your load versus settlement.

Now, come to your punching shear failure. In punching shear failure let me draw it this is your footing this is a q and this is your depth of the foundations and this kind of load settlement load for unit area pressure intensity q, load for unit area your settlement your suppose to get it in what kind of foundation soil your expecting a punching shear failure particularly in case of loose sand or soft clay. Then it has been in case of punching shear failure as its name is punching. It will go inside, the foundation will go inside your particularly inside this your soil bed. So, another classification has been given local shear failure as well as general shear failure. So, that has been given by Vesic's he has given a certain criteria I will explain it.

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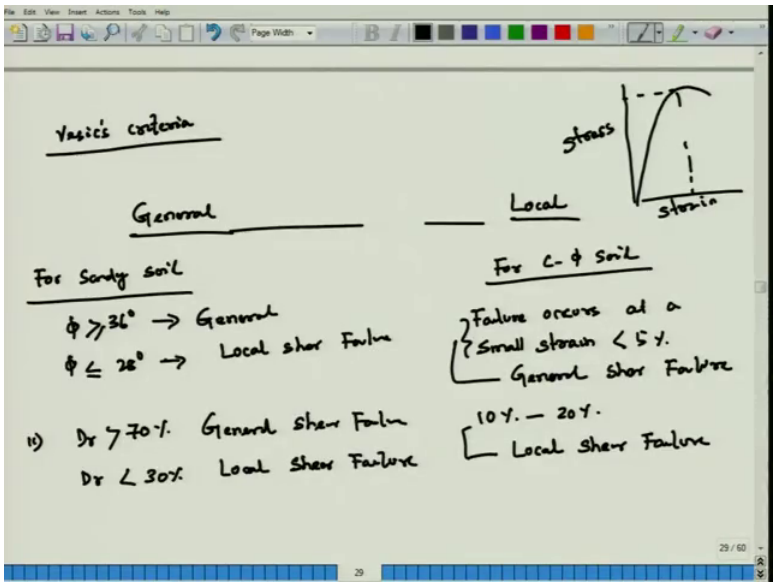

So, particularly for as per Vesic's, Vesic's criteria its general and second one is your local shear failure. So, particularly for general shear failure and local shear failure if I put it here general and local how do I distinguish for sandy soil, for sandy soils if phi values greater than equal to 36 degree general it is, general shear failure phi less than equal to 28 degree that is your local shear failure.

So, intimated value will be extra polluted. Now it is general and local in between what is the conditions, if we look at phi is greater than equal to 36 degree it is general shear failure, phi is less than equal to 28 degree it is local shear failure. Another case is here, second case is here if relative density is greater than 70 percent in that case we say it is general shear failure. If relative density is less than 30 percent it is called local shear failure. So, for c phi soil it is particularly sandy soil for c phi soil for c phi soil in general shear failure soil specimen or failure occurs failure occurs at a small strain less than 5 percent this is your general shear failure means a local shear failure it is 10 percent to 20 percent then in that case it is local shear failure.

Now, let me summarize. So, types of failures in soil at ultimate load particularly it is required for your foundations. Category 1 is your general shear failure, second is your local shear failure, third one is your punching shear failure. In general shear failure generally it occurred if you foundation soil dense sand or a stiff clay look at the condition if foundation soil is dense sand or stiff clay. In that case you are suppose to get a failure

means particularly peak in a load versus settlement diagram increases peak and decreases, so that you can very easily find it out ultimate bearing capacity. Another part is in that case generally heave is observed, this is your heave I am the periphery of your foundations these are all indication for your or condition or criteria for your general shear failure.

Now, come to local shear failure generally it happened a foundation soil is constructed over medium dense sand or clayey soils and you are suppose to get if load versus settlement peak is never going to happen it increases settlement increases with increase in low. In punching shear failure generally it happens if your foundation soil with in loose sand or soft clay in that case it punch it goes inside, goes inside. So, entire foundation goes inside this is your load versus settlement diagrams.

Now, come to Vesic's criteria Vesic's as given a criteria general shear failure and local shear failure or particularly sandy soils if phi angle of internal frictions phi is greater than 36 degree, greater than equal to 36 degree that is called your general shear failure. If phi is less than equal to 28 degree this is called your local shear failure in between what will happen suppose phi is equal to 30 degree. So, basically you have to extra pollute once I will after that our bearing capacity part will be I will cover bearing capacity. So, if phi values 30 degree in between general and local shear failure it has been checked termed as either general nor local or either it is a mix shear failure. So, bearing capacity will be extra polluted or intra polluted between phi greater than equal to 36 degree and phi less than equal to 28 degree.

Another case if relative density is greater than 70 percent in that case it is general shear failure if relative density is less than 30 percent it is local shear failure. For c phi soil generally failure occurs at a small strain, less than 5 percent how do you know that suppose you are doing a c phi soil triaxial test stress versus strain, stress versus strain. In that case you are getting a peak and that to be termed as failure and is strain should be suppose to be less than 5 percent in that case also you can say general shear failure has happened if strain at failure particularly soil bearing come 10 to 20 percent this case is called local shear failure.

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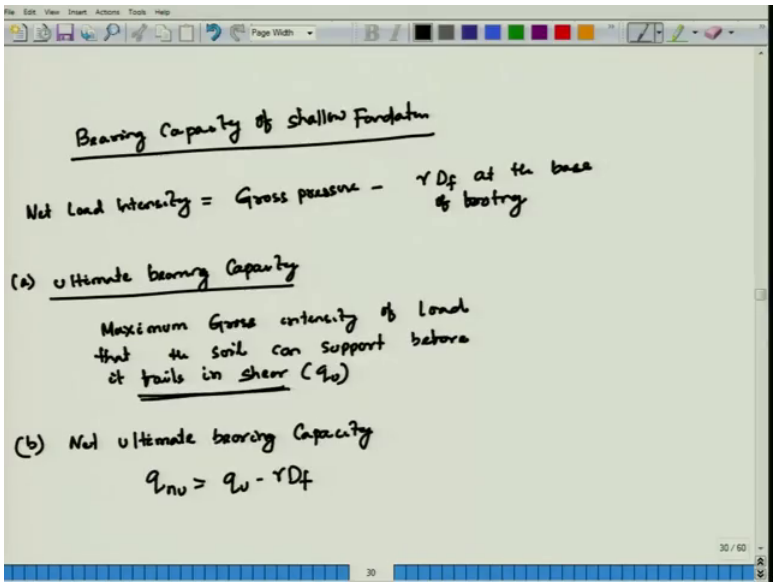

Now, let us start with your bearing capacity of shallow foundation. So, there are different terminologies. So, there are different terminology before you go for Terzaghi's bearing capacity theory it is your net load intensity - net load intensity is equal to gross pressure minus your over burden pressure, over burden pressure that means gamma D f; over burden pressure at the base of footing. Most importantly now the terminology what I am saying this will very offend we are going to I am going to a studied many times. So, I will designing this foundations ultimate bearing capacity, net ultimate bearing capacity, nets bearing capacity, gross bearing capacity. So, this should be in your mind once I am saying what is ultimate bearing capacity you can bearing easily catch it.

So, now first part is your ultimate bearing capacity. Ultimate bearing capacity is your maximum gross intensity of load definition is maximum gross intensity of load that the soil can support before it fails in shear. Generally notation is q u if I say ultimate bearing capacity of the foundations of the footing what is it mean? Look at here maximum gross intensity of load that the soil can support before it fails in shear before it fails in shear by means of shear only this is your ultimate bearing capacity the terminology is your q subscript u.

So, B is your net ultimate bearing capacity net ultimate bearing capacity q n u is equal to q u minus gamma df. So, here it is a maximum gross intensity you can write it maximum net intensity of load that the soil can support before it fails in shear; that means, q u

ultimate bearing capacity minus gamma D f, gamma D f is your gamma over burden pressure or gamma df up to your foundation level.

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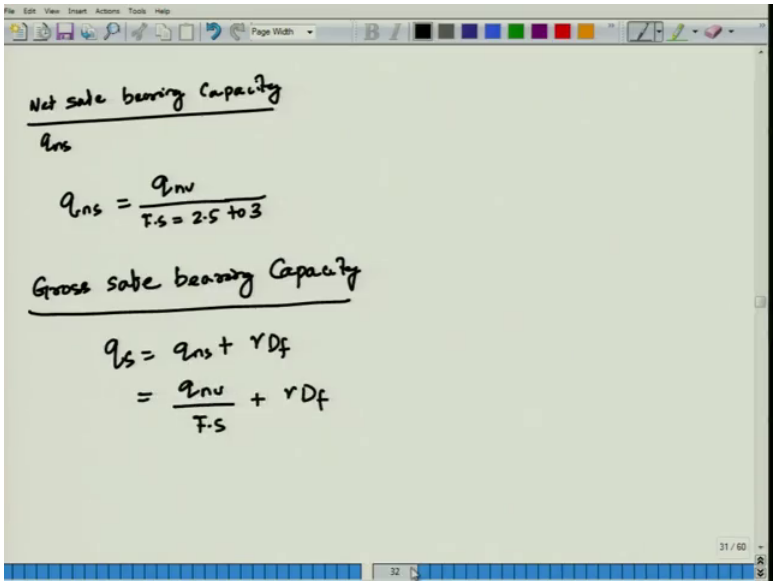

Now, net safe bearing capacity, generally net safe bearing capacity we write it q n s - q for is ultimate, n for your net, s for your safe. These are all universal notations you can it write it c n s or capital Q n s you can it, write it small q n s.

So, nets bearing capacity is if I write it q n s which is equal to q n q divided by your factor safety 2.5 to 3, q n q is your what, q n u sorry q n u is your what? Net ultimate bearing capacity with a factor safety, divided by your factor safety this factor safety for your shear and it generally taken as 2.5 to 3 for foundations. So, nets of bearing capacity is your net ultimate bearing capacity divided by your factor of safety and facto safety is varying 2.5 to 3.

Now, gross safe bearing capacity I can write it if it is net safe bearing capacity you can write it gross safe bearing capacity. So, gross safe bearing capacity net safe bearing capacity plus gamma D f this is your over burden which is equal to net ultimate bearing capacity divided by your factor of safety plus gamma D f, this is your gross safe bearing capacity.

Next, net safe settlement pressure, net safe settlement pressure which is equal to q n p small q n for your net subscript, then p is your pressure. So, net safe settlement pressure.

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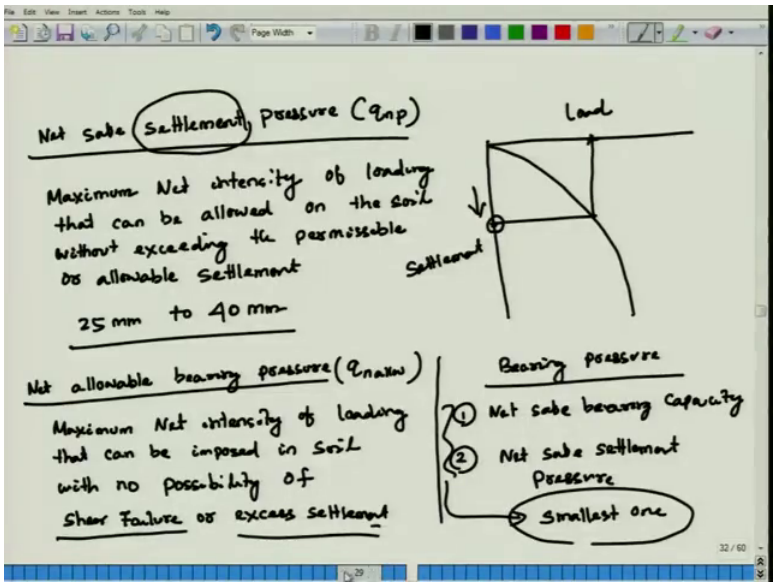

So, what is it mean net safe settlement pressure. Maximum net intensity, maximum net intensity of loading that can be allowed on the soil, on the soil without exceeding the permissible or allowable settlement. Generally for individual footings the permissible settlement is bearing between 25 mm to 40 mm as for burro opinion standard look at here, net safe settlement pressure, net safe settlement pressure the terminology is coming net safe settlement pressure maximum net intensity of loading it is a maximum net intensity of loading that can be allowed on the soil without exceeding the permissible or allowable settlement.

If I draw load versus settlement or may be pressure insensitivity versus your settlement generally settlement in mm, so what is your allowable settlement look at here? If this is my load versus settlement cause, what is a permissible or allowable settlement let us a 25 mm this is your 25 mm you draw it. Corresponding to that load you can say that that is a maximum load intensity that is allowed on the soil considering your allowable settlement of your 25 mm that is why it is called net safe settlement pressure. Then another one is your net allowable bearing pressure q n p, net safe bearing pressure net allowable bearing pressure. So, you can write it q n allowable n for your net allowable. So, it is your particularly if you look at here maximum net intensity of loading, maximum net intensity of loading that can be imposed in soil with no possibility of shear failure or excess settlement.

So, if I write it, so bearing pressure in that case, bearing pressure – one, net safe bearing capacity; second, net safe settlement pressure, out of these comparing both these smallest one is consider as net allowable bearing pressure. So, net allowable bearing pressure what does it mean I wrote it, in intention I wrote it I could have said. So, you can note it down. So, maximum net intensity of loading, maximum net intensity of loading that can be imposed in soil with no possibility of you can say that with no shear failure; that means, shear failure means what is it means? No bearing capacity failure; that means, net ultimate bearing capacity failure net safe bearing capacity, so no net safe bearing capacity or no excess settlement; that means net safe settlement pressure. Find it out net safe bearing capacity considering shear failure, find it out net safe settlement pressure considering permissible settlement - out of this 2 which is minimum or which is the smallest that one you have to consider for your net allowable bearing pressure, the symbol is q n allowable.

So, these are all what we have covered today. We have covered today shallow foundation criteria, D f by B less than 1 generally this is your Terzaghi has given. Later on the research a changed, so D f by B between 2 to 3 that has been called shallow foundation more than that it is your D foundations, then what are different types of failure in soil at ultimate load. General shear failure, local shear failure as well as punching shear failure, then basic has given some criteria basic criteria this is called general shear failure as well as local shear failure based on your phi value angle of internal fix on of soil, based on your failure criteria means strain rate - small strain or large strains. Then terminology definitions bearing capacity of shallow foundations net load intensity, ultimate bearing capacity it is q u, net ultimate bearing capacity q n u, then net safe bearing capacity with facto safety 2.5 to 3 gross bearing capacity then net safe settlement pressure q n p then net allowable bearing pressure q net allowable.

I will stop it here. So, next class I will start it Terzaghi bearing capacity theory, this is a basic theory Terzaghi has given or your bearing capacity calculation and now this once the bearing capacity is over then you will go for settlement what are the different settlement analysis, then once it is over then you will go for foundation designs, shallow foundations then will go for depend other chapters.

Thank you.