Foundation Design
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Lecture – 4B
Subsoil Investigation or Site Investigation
Part-8

Last class I have covered foundations. Basically classification it is 2 types, if I divide into 2 types: shallow and deep.

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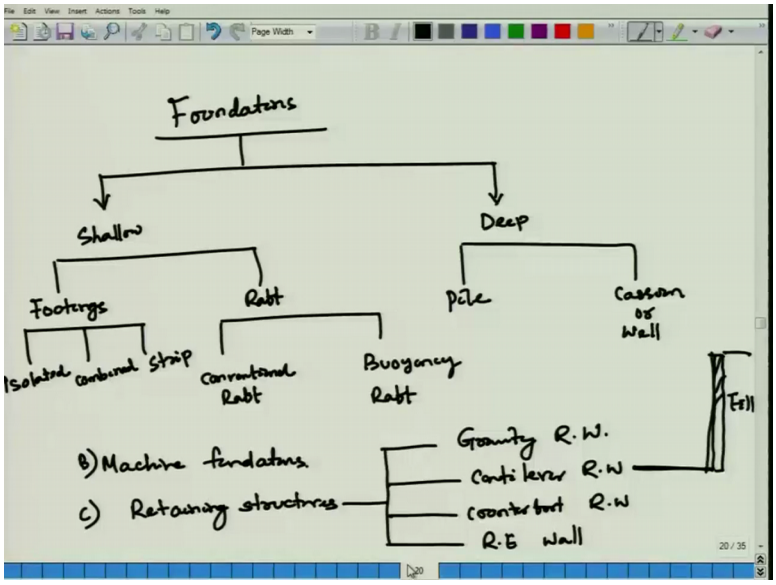

Shallow again footing and raft: footing is isolated, combined and strip footing a raft, conventional raft, and buoyancy raft deep foundation. If I classified into 2 parts: one is your pile foundations this pile foundation may be a pile raft friction pile end, bearing pile that will be depending upon how it transfer load to the ground surface caisson or well foundation.

Generally, they have been provided in bridge or Railway Bridge. Then of course there are machine foundations to require to install machines over a foundations then retaining structures. In retaining structures there are 4 categories conventional gravity retaining wall RWG retaining wall cantilever retaining wall, counter fort retaining wall, RE wall reinforced earth wall. This I have covered with your foundations started with these, and then start with your isolated footing.

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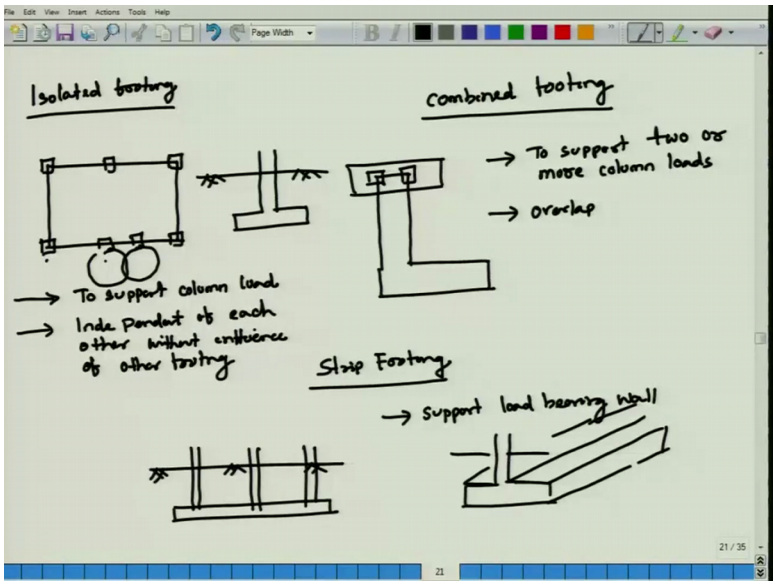

Isolated footings, if you look at here suppose this is a plan of a building there are separate columns separate columns here as well as here. Then if I can take it, isolated means it is a single footing without interference.

So, where this isolated footing has been utilized or may be adopted to support column load of a building. Then it is Independent of each other without influence of other footings. If I say isolated footings generally, these are all independent footings. If this is the plan of a building if I say this is isolated footing this is one isolated footing. Generally, it is support how you load transfer load transfer from superstructure to beam to column to foundations. Generally, it supports your individual column loads at the same time, it is independent neither these are of this footing are going to influence each other. So, in that case it is isolated footing.

Then come back to combined footing, combined footing look at the plan one of the plan here look at the plan here. And there is a footing here, there is a footing here and it has been combined.

So, it has been designed to support 2 or more column loads. And isolated footing; that means, why there is a combined footing when there is a overlap, overlapping there is a overlap of 2 isolated footings. If this 2 footings here they are very close to each other suppose there overlap; that means, pressure intensity or pressure bulb is overlapping each

other. In that case you can combine the 2 footings and prepare a one footing. In that case this is called combined footings.

Then third one is your strip footing. Strip footing if I draw it is strip footing, this is my ground surface. And load bearing walls strip footing is a it is support load bearing wall. And from long to narrow continuous foundations, if I draw a strip footing in 3D view, in 3D view how it looks? Here it is a wall this wall has been supported. And this wall here there is a wall here there is wall here there is wall in that case it is called strip footing. So, particularly in shallow hotspot is your footing and footing, it is 3 parts isolated footing classified in to 3 parts isolated footing combined footing and strip footings.

Now, come to next raft or mat foundations. Raft or mat foundation means; that means large number of columns is founded on one single slab when individual column footing at together found to be occupied.

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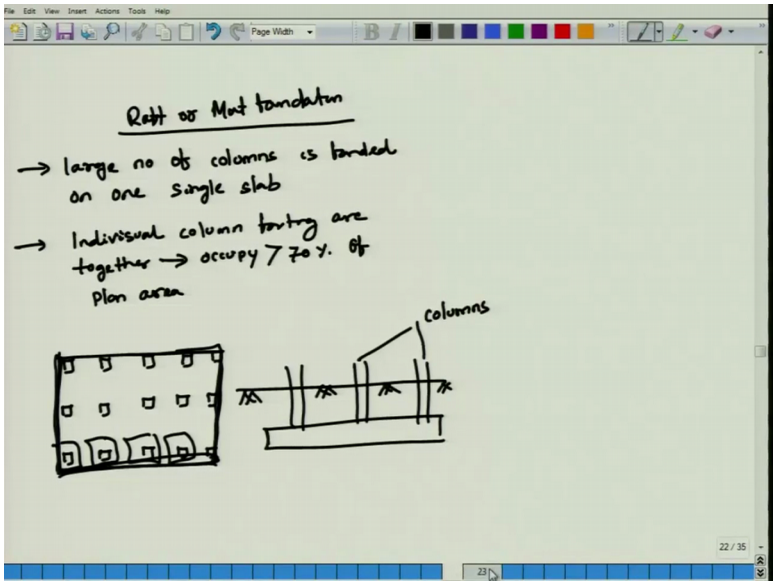

Individual column footings are together. And it occupies more than 70 percent of plan area. Then in that case you can go for raft foundations. If you look at here there is a plan of this building. Then there is a column here, column here, column here, column here, column here, column here, column here, column here, column load here, column each here, column here, column here. This is here and this is here.

So, in that cases there are many columns are there. And there will be overlapping with each other, first condition. Second condition is it is occupying 70 present of your plane area, if you independently if you do it is occupying 70 percent of plan area in that case what has been done a single slab. A single slab; that means, this will be made a single slab with a single slab these are not the walls like previous these are all your columns; these are all your columns. That means, a single slab has been made over these columns have been erected. So, in that case it is called raft as well as mat foundations.

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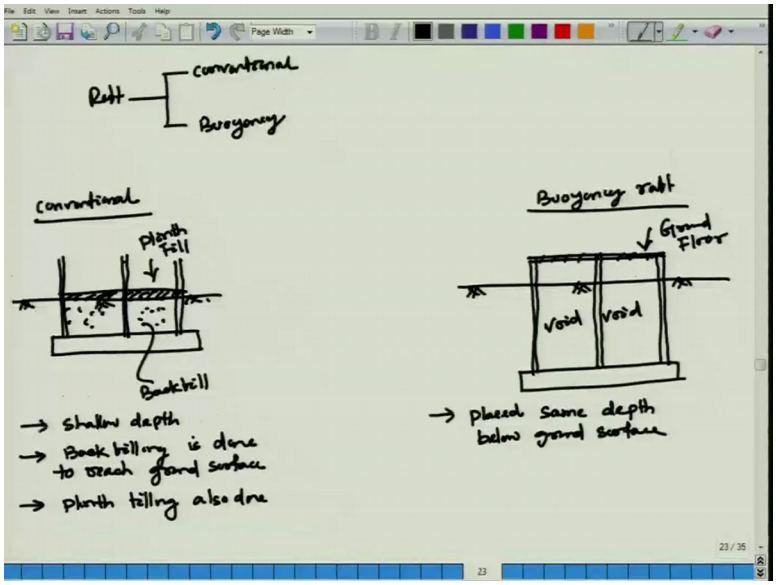

Now, go to the next that is your there are in raft and mad foundation, there are 2 types if I say raft as I said earlier this is your conventional. And second one is your buoyancy raft conventional and buoyancy raft if I go for your conventional here. And here is your buoyancy raft, conventional raft and buoyancy raft. If you look at here let me draw the figure first, ground surface and there is a single slab. These are all your columns. This is your column. This is your plinth level, or here it is a it is backfill.

And in this case, this is your plinth fill in conventional raft it provided a shallow depth and back filling is done. Back filling is done to reach ground surface. Then plinth filling is also done, plinth filling also done so that you can start the floors. So, conventional raft it there is single slab with these columns are there. And back filling has been made. So, that you can reach up to the ground level, and then plinth filling has been made. So, that

ground floor first floor second floor it will continue like this this is your conventional raft.

Now, come to your buoyancy raft, if I draw it a buoyancy raft. Then there is a slab here single slab. Draw a column here, draw a column here. It is column one column load here, one more column load here. Then you make it here that is your ground floor. And this is particularly void. This is your void. If I can write it placed same depth below ground surface.

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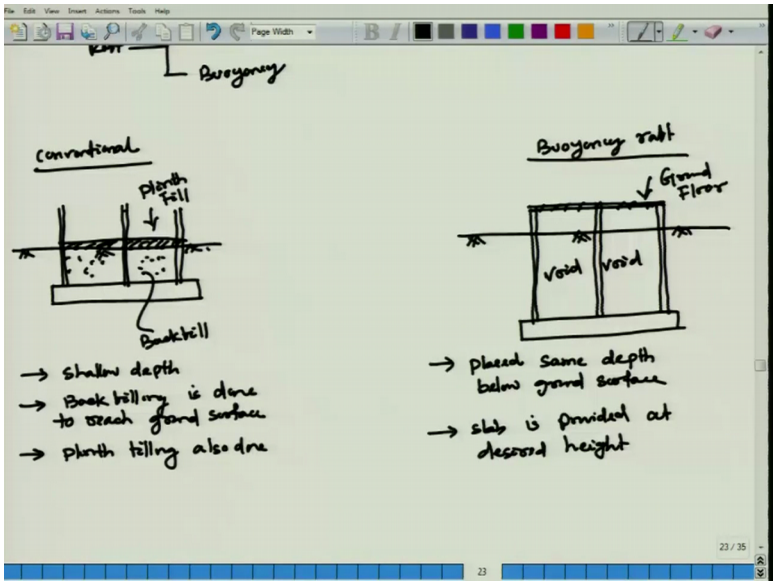

Then ground floor slab is provided; that means, slab is provided at desired height. It difference between your conventional raft and buoyancy raft. In conventional raft there is a back filling you make the back filling. So, that you can reach up to your ground surface, but in buoyancy raft placed same depth below your ground surface. And this there is no filling there is a void that why this is called buoyancy raft. More detail I will discuss as the class progress, this is your basic introduction to your foundations different kind types of foundations.

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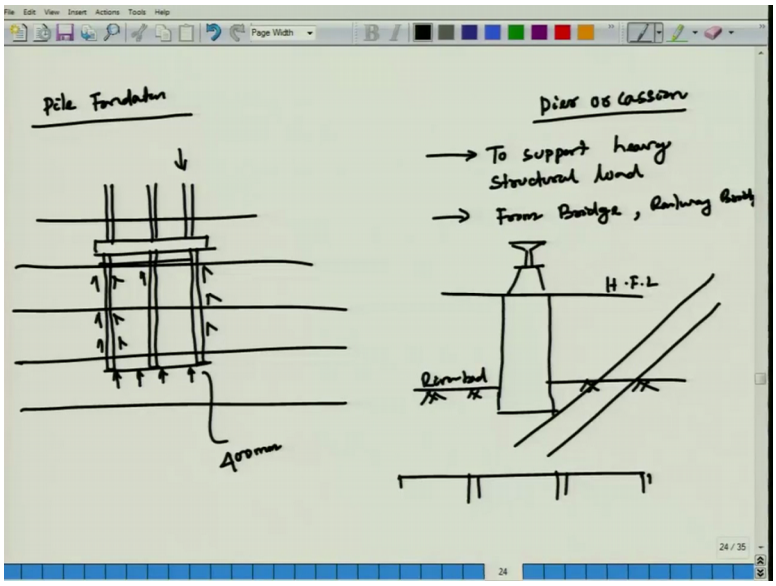

Now, there are deep foundation one is your pile foundation, other is your pier or caisson foundation, pier or caisson foundations. In pile foundations what will happen? Pile foundation what will happen? When this bearing capacity of this soil is not adequate to support your structures are shallow depth; that means, this is the case where you are not getting the bearing capacity of the column load; that means, what your planning for a foundation are shallow depth bearing capacity of this soil is no adequate.

That means, you are getting say bearing capacity of this soil of deep of depth. Then in that case you can go by means of your pile foundations. Pile foundations are generally provided by means of groups, or with pile raft or without raft or with a cap. So; that means, if it is connected piles with a cap monolithically we can say it is a pile raft. This particularly load transfer from column to raft then raft to pile and from pile to soil. Depending upon the soil conditions depending upon your soil condition it may be a friction pile.

That means, if it is a friction pile what does it mean, by means of group actions by means of group actions by means of side frictions enter load will be transferred. If it is only end bearing by means of end bearing resistance, end bearing resistance. It resists the load coming come your superstructure. If I say both end bearing and both frictional piles; that means, part of the load has been taken by means of side frictions part of the load coming from columns from this superstructure has been taken by your end bearing.

So, this is case of your pile foundations then pier and caissons pier and caissons, particularly it is used to support heavy structural load. Heavy structural load like from bridge or may be Railway Bridge. Basically, if I draw a pier or caisson foundations, it is a large diameter pier are there. Large diameter piers are there. Here it is large diameter piers are there. Then slab has been made and depth has been made to support your structure.

This generally the diameter of the piles as per bureau of Indian standards it is minimum should be 400 mm, 350 to 400 mm 35 centimeter or forty centimeter, but here it is bearing more than a one meter. A large caissons particularly where there is a and this pier and caisson provided long the rivers. Flow of the water is there and you penetrate this caissons or piers inside your river bed. This is my river bed and hfl high flood level where it goes water up to this river bed. Bellow river bed you penetrate and it is a large structure very large structures.

So, it will go up to deep start of your soil here it is also a deep start of your soils. So, there are also pile foundations as I said different types of the pile foundations frictions end bearing and both end bearing and frictions as well as pile foundation with a cap or pile raft. Raft connected with pile sometimes you want to provide a raft at the generally raft has been provided at shallow depth.

Sometimes it is not supporting your settlement and bearing capacity are not coming within your permissible limit. Then raft with connected with a pile of small l by d length embedment length. It is satisfies your criteria. This is what your pile foundations pier and caissons particularly bridge, railway bridge, highways bridge, where this big piers are there and it has been basically provided where the near the rivers if there is a river and at the 2 sides, I can say these are my piers abutments and in between I can say these are my piers and at the sore it has been called abutments.

So, this is all about slight description of your classifications, foundations 2 types shallow and deep. And shallow is your again 2 types footings and rafts footings has been classified isolate combined and strip, raft classified conventional raft and buoyancy raft deep foundation basically classified in to 2 pile foundation and caisson foundations.

Now, come to your isolating footing it basically to support column loads at the same time 2 isolated footing should not overlap. And combine footing when there is a less space 2

column loads are there and you want to provide support in that space 2 column loads and overlapping is there. So, you combined it in that case, it is combined footing then strip footing particularly strip footing to support load bearing wall this is your footing this is your wall coming out this is most combined residential buildings. Then raft or mat foundations what will happen if you remember here as I discussed your combined footing 2 isolated footing

In this case of your raft and mat foundations if you look at here the area is pre defined this is the available area for your constructions. So, in that case multiple column loads are coming, you cannot provided isolated footing because there is a overlap at the same time it occupies more than 70 percent of your plan area; that means, if I provide a isolated footing here, isolated footing here, isolated footing here, isolated here. It occupies more than 70 percent of your plan area. In that case takes it as a single slab, this is a single slab.

And this is a complete single slab. And with this slab this column has to be connected monolithically, and this is called raft or mat foundation generally it has been provided at shallow depth raft or mat foundation has been classified in to 2 type. One is your conventional raft other is your buoyancy raft. In conventional raft there is a single slab and it has been provided at shallow depth.

Generally, back filling has been done to reach your ground level then plinth filling is there. So, that your flooring has been stated, but in this case buoyancy raft there is no back filling you can start your plinth level ground floor as for your choice there is a void here. So, this is the difference between conventional as well as buoyancy raft. Then come to your pile foundations pier or caisson foundations; that mean, your deep foundations pile. Foundations when at shallow surface bearing capacity of soil is not good enough to support your structures, to support your structure load coming from structure to beam, beam to column to foundation in that case you can go for a pile foundations. Generally, diameter pile diameter is 350. There 100 to 400 mm minimum diameter.

So, you can provide pile as a single as well as group. Generally, for foundations group is prepared. Sometimes pile can be provided with a pile caps, sometimes pile can be provided with pile raft; that means, cap and pile has been connected monolithically. And the load transfer mechanism of your pile foundation is it transfer load to your ground

surface of to your soil by means of frictions side frictions by means of end bearing or end resistance or by means of both friction as well as some part of your frictional resistance some part of your end bearings. Piers and caissons generally it provides to support your heavy structures particularly in bridge or Railway Bridge, where river is passing there is a water current is there and large diameter piers penetrate below your river bed. So, this is all about your classification of your deep foundations.

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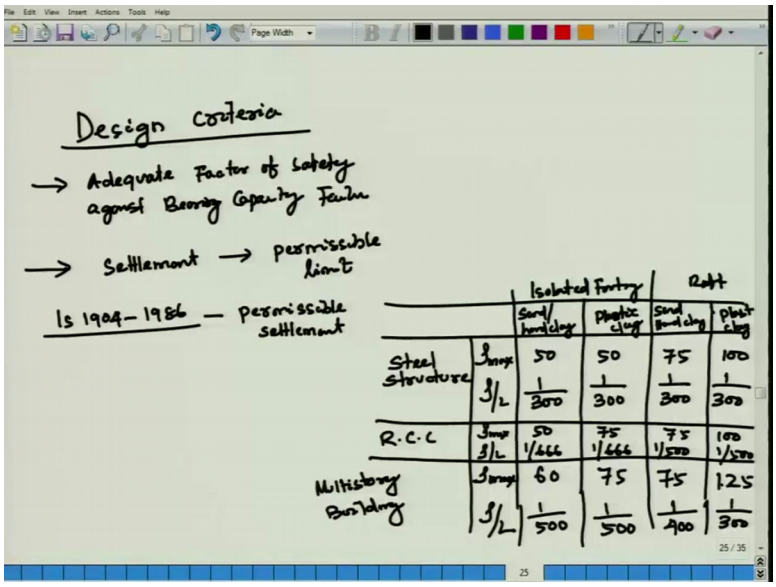

Now, come to your design criteria as an geotechnical engineer in design criteria. So, there are 2 design criteria, one is your adequate factor of safety against bearing capacity, failure then settlement within your permissible limit. Settlement means both consolidations as well as immediate settlement as well your differential settlement with in your permissible limit. So, 2 design criteria. So, one is your bearing criteria, failure adequate factors of (Refer Time: 26:32).

Generally, 2.5 to 3 has been taken second part is your settlement. So, it should not be access settlement. So, it is should be within your permissible limit. So, as per IS code you can down it down means download it IS 1904; 1 9 0 4, 1 9 8 6. It is there it is about your permissible settlement. Permissible settlement if I put it in this way, I put it isolated footing. Then 2 part is your second part is your raft. In isolated footing one is your sand or hard clay.

Second part is part is your plastic clay. Raft again sand or hard clay. Second part is your plastic clay; plastic clay, then steel structure. In steel structure rho maximum is your maximum permissible settlement. Then rho by l is your difference in settlement, 50 these are all in mm 50, here it is 50 here it is 75. Here it is 100. Then here it is your 1 by 300 1 by 300, 1 by 300. Then 1 by 300; this is all about your steel structures. Now RCC structures, I write it RCC reinforce column. RCC structures then rho maximum and rho by L. This is your 50, 75, 7500 and this will be your 1 by 1 by 6, 6, 6.

Then 1 by 6, 6, 6, and this is your 1 by 500 and this is your 1 by 500. Then multistory building last one is your multistory building, multistory building this is your rho maximum this is your rho by l here it is 60, 75, 75 125 here it is your 1 by 500 1 by 500, 1 is to 400. And here it is your one is to 300. Why I wrote it I could have said you can collect it bureau of Indian standard provisions some collage it is not possible to get it that is why I write it so that you can note it down.

So, different are settlement in the ratio, but maximum permissible settlement these are all 50 50 75 100 50 75 75 100 60 75 75 125 these are all mns. So, this is what bureau of Indian standard has been proposed, particularly 3 cases one is your steel structures second is your RCC last one is your multistory buildings. So, this is all about your classification of foundations designing criteria and what is the provision for your settlement bureau of Indian standard. This is an introduction.

Next class I will start your shallow foundation along with your bearing capacity main topic, I will start it.

Thank you.