Application of Soil Mechanics
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Lecture - 10

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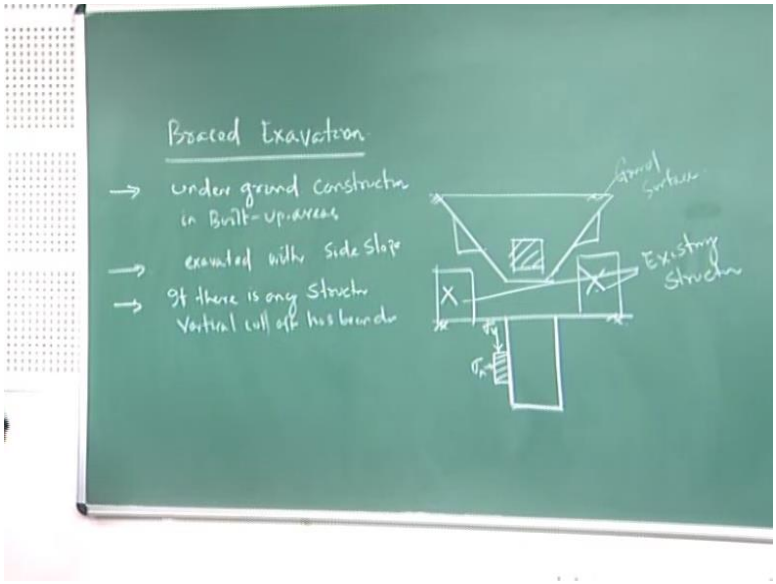

Next chapter we are starting that is your braced excavation means where it is required, first thing is once we are saying that the application of soil mechanics, topic is your braced excavation, and where it is required. Particularly for underground construction, in built-up areas, generally what happened, it has been excavated with side slope. If I draw this is the ground surface then how this excavation has been done by going through the side slopes, it has been done. So, if there is any structure, then vertical cut off has been done.

So, if I draw, there are two figures, one is with your side slope, other is your other figure is your kind of vertical cut off. And with these, this is sigma b, this is your sigma n what is your braced excavation, generally braced excavation is a underground construction, where this underground construction has been used. For example, metro rail, where this underground construction generally done. And now you can say that metro rail underground construction why this braced excavation is required. If you look at that generally underground construction has been done by means of cutting from the ground surface.

If this is my ground surface from side slope by digging inside by side slope, so that it will be stable, you can cut in inside, so that construction can be done below the ground. But problem arises when this problem arises, suppose like a crowded or metro areas, metro areas suppose they are already building existed in the ground surface near by the excavation, what will happen you cannot do this excavation by means of your side slope it is not possible rather you have to go for vertical excavation. The moment you go for vertical excavation to make it stable, because this vertical excavation, it is stable up to certain depth for granular soil, you cannot do this vertical excavation, but for cohesive soil, you have to go for vertical excavation, and that to up to a certain depth beyond this, it is not going to stable.

So, to make this stable braced excavation is generally braced structure has been provided and so that you can cut or you can excavate vertically that is why this vertical means braced excavation comes into picture. This is your existing structure; that means, for a area like metro cities underground or metro rail are the construction we have to do with vertically you can go for below the ground surface, and will go for construction, it is not for possible, sides slope excavation you cannot do it. So, that is why in that case you need to have your braced excavation or braced support you have.

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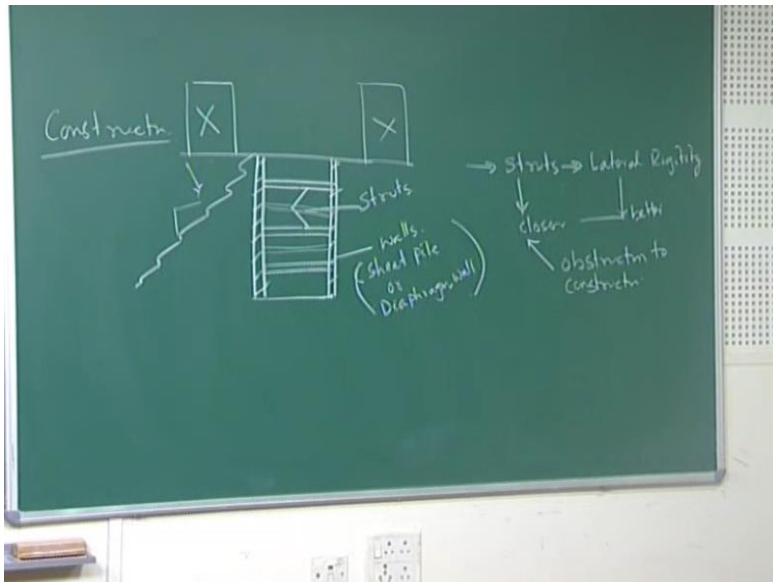

Now how these construction has been done, this is basically a introduction class. If we look at here, in simple way, there is a structure, here it is a structure existing, here it is

structure existing, and there is a underground construction maybe metro rail is passing somewhere else here. It is proposed to half metro rail construction below here like Calcutta as well as a Delhi.

So, in these case, you cannot do the movement you go for side slope kind of this side slope excavation by means of side slope, what will happen this structure, it will topple or may be some settle may to occur. You do not want, it should be some kind of disturbance should be there in the structure. So, in that case what you are suppose to do, you have to go for vertical excavation by means of braced structure. If I draw it now look at these, how the vertical excavation has the done, this is called struts, and these are walls, walls by means of sheet piles or diaphragm wall.

So, the construction techniques is like that; that means, this vertical excavation has been done by your braced structure. This braced structure consists of at the top you go for construction what is that up to certain depth up to certain depth you exhibit, then insert your pile, sheet pile or diaphragm wall. Then provide your then go for another excavation then provide your for distorts. So, that what will happen, you can go vertical excavation whatever the depth you want to do; at the same time, it will hold the pressure both sides, it is not going to fail.

So, this is a simple construction techniques have these in details we going to later on. So, if I say that what is braced structure, braced structure is consists of kind of a strut and wall. It is struts as well as walls, this wall may be a sheet pile or means of a diaphragm wall. So, what will happen, before construction the lateral rigidity, why this strut you provide, struts it is required, so that lateral rigidity closer this will be kind of it is a better and it has also disadvantages like obstruction to construction that means these struts why were providing in a braced these structure particularly, it will improve your lateral rigidity. That means, lateral deflection and lateral bending will be less and more the closer this struts lateral rigidity will be better.

Once you are saying that lateral rigidity is better; that means obstruction to be your construction. That means, used to compromise between the spacing of this struts, while this construction of particularly braced structure or braced excavation below to the ground surface you have to compromise with the number of struts, and minimize this spacing of this struts during the construction. Otherwise, what will happen more this

struts are going to provide at regular interval, what will happen here, it is very difficult to have your construction and process, you cannot do the construction.

So, these are evaluated techniques, all the construction has been done. Now let us go to the failure of braced structure what are the different modes. This is an introduction where this braced structure of why this braced excavation is required particularly once again in one metros is not possible to exhibit by means of pipe side slopes rather you need to have exhibit means as like a botanically. You have to do to ground below the ground surface for that you need to have a braced structure consists of the movement; you say that it is braced structure. It consists of struts as well as the walls as the struts has been provided to improve lateral rigidity and walls has been provided to prevent the flow of soil or water inside these braced structure.

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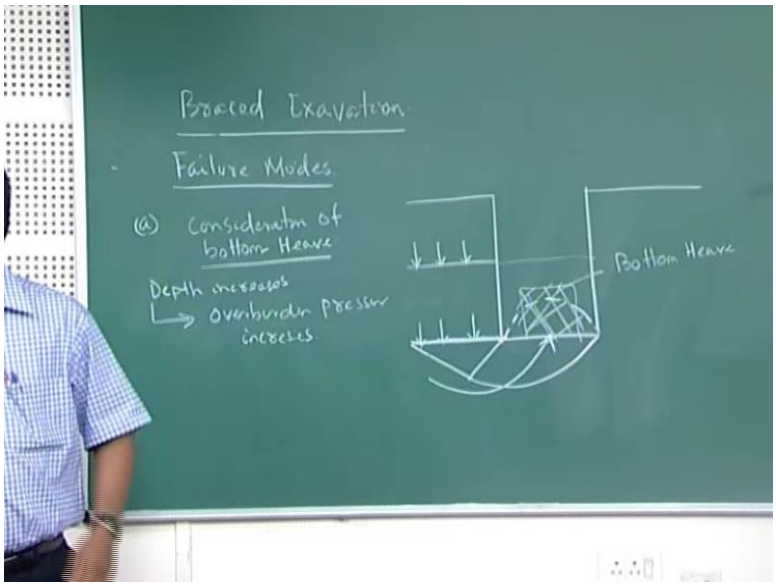

Now, next step is your now you are coming back to this topic. Now this failure modes what are the different kind of failure modes in that program one or sheet pile wall with your struts or braced structure part is here consideration of bottom heave as the increases this is my depth. If we look at here how the bottom heaves reduce, this is your bottom heaves, that means, as depth in increases over burden pressure increases. When over burden pressure is it will see how the bottom heaves once into picture, what is the bottom heaves. If see this is the depth of the excavation look at here, up to this depth of the observation, it may not be possible, it is not going to occurs that bottom heaves. First we

understand what is the bottom heaves if this is my depth of the excavation as depth of the excavation from here to here, what will happen, side this side is a full of soil.

So, what will happen over bottom pressure will increase the movement at the bottom at the bottom if over bottom pressure is more than if over bottom pressure is more than bearing capacity what will happen by means of this pressure this will go. So, there will be a some kind of heaves soil will come out in the exemption area. So, he will be produced. So, because of this heaves what will happen whatever the construction you have made it it made. So, this is called consideration of bottom heaves in design.

So, it is not possible for a excavation if have to go for a excavation. So, you need to have braced structure difference of sets once you go for a difference of sets; that means, of a you will happen a over bottom pressure will be more. Once over bottom pressure will be more then you are capacity then soil here in side push inside excavation, there will be a heaves kind of thinks will form; that means, whatever the structure or construction here it may over the period of time.

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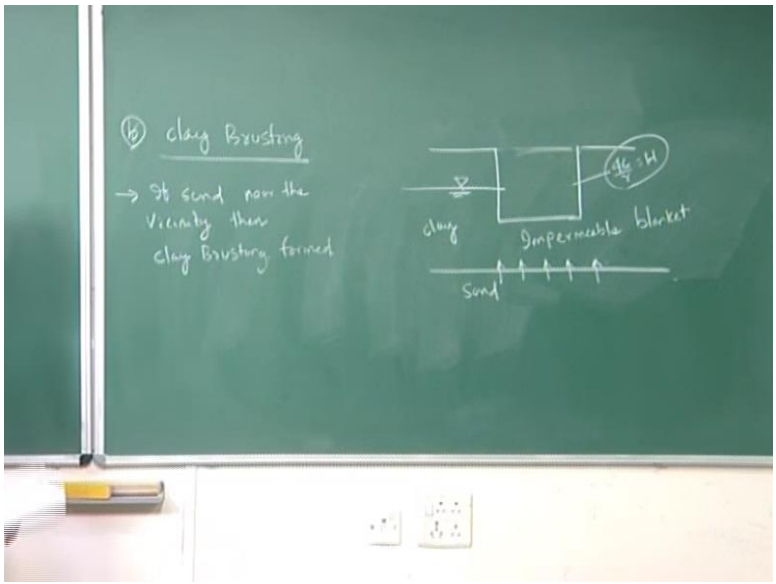

It may fail by means of a bottom heaves this is one of failure more one of the failure mode now second will mode is here kind of a clay bursting clay bursting means it is plan you have your excavation and there is a clay layer excavation in the clay layer. So, then below this clay, there is a sand. So, this is your impermeable blanket.

Now, there is a water table some are else here. So, what do mean by claim bursting; that means, suppose we imagine suppose we imagine we can go for a vertical clause. If there is a clay generally for cohesive soil vertical clause up to four c y gamma without any support, if there is a clay support cloud the say soil and vertically we can do without your braced structure up to height of four c y gamma c is your unit cohesion and gamma. Once we go beyond this is there is a clay lay out and below there is a sand and below there is sand it may possible that this water table is here clay bursting means because of water table and layer, it will come out clay bursting clay come out in your excavation.

So, that is other way of kind of another failure mode; that means, the condition is if sand near the vicinity, and then your clay bursting form clay bursting is nothing but it is an impermeable layer impermeable blanket and the is a sand because of water table this enter part will be to a excavation. So, that is called second failure mode that is called a clay bustling

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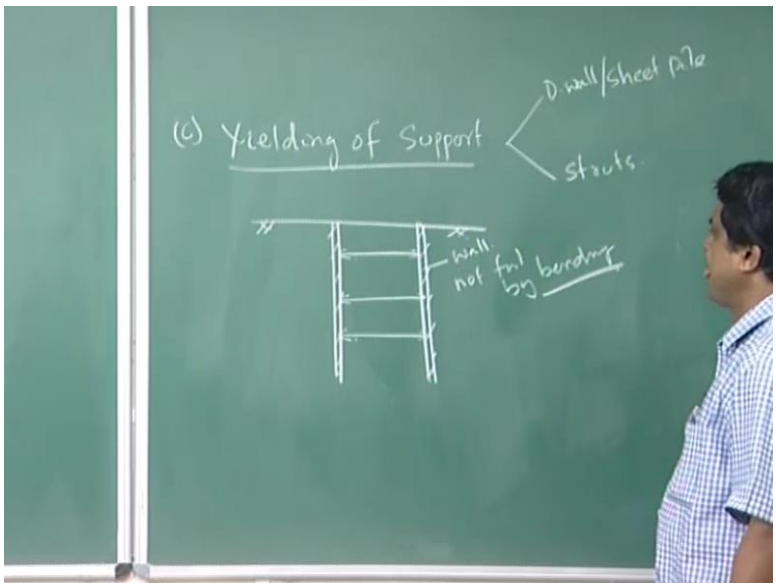

Now, third failure mode is a your yielding of support yielding of support that means, of support has been constructed in braced excavation by means of diaphragm wall one of all sheet pile one. And struts it you look at the bray structure; that means, a consists of diaphragm wall or sheet pile end with this along with these these are earlier struts. Now, if I construct, if this is your grounds surface and vertical excavation has been made by means of you have breast structures with the help of the breast structures the vertical

excavation has been made what will happen u should take enough k r.

So, that the oil wood not fail by a bending oil wood not fail by a means of bending; that means, wall not fail by bending for this called yielding of support. If one pile, by means of bending means the support structure will be yielded so; that means, you have to consider this bending this walls would be safe against the bending the stop wall to pail by the means of bending appropriate stop will provided that regular that interval. So, that yielding of this supports or the failure of here to wall by means of bending should be avoided this is your hard failure criteria till now once it has there are three one is your by means of bottom heaves. Second is your clay blasting third is your yielding of your support yielding of your wall support then fourth is your ground movement.

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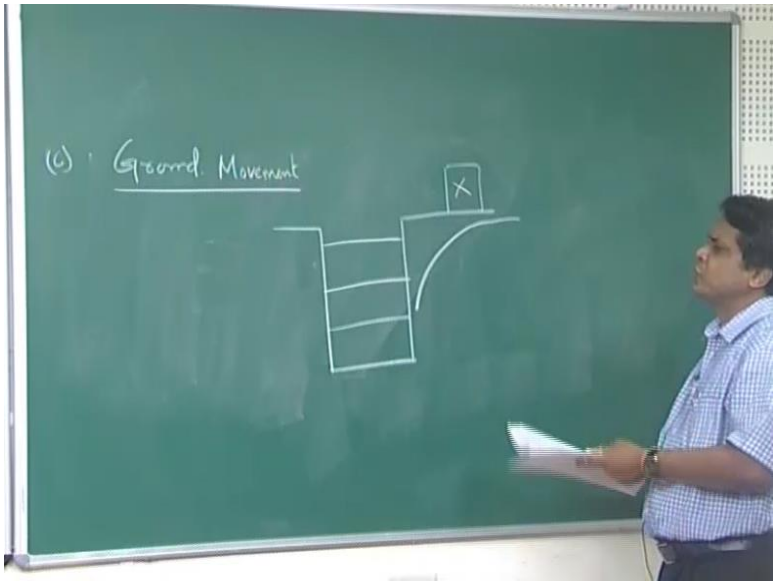

Look at this construction this excavation has be in made with the help of brace structures then what ever happen if there is a nearby structures there is a nearby structures enough prayer should be we take end once we do the excavation enough k r should be take a for that this tail nearby should not moved should not moved because of excavation these; that means, you willtake care of all these things the ground movement should to be as minimum as possible definitely there will be a ground movement, but try to do as minimum as possible otherwise what will happen because of your vertical excavation nearby structurally fail by means ground movement excavation.

So, this another condition and another failure criteria has to be consider for your design

point of the do now how the conceptual procedure has been made earlier i said the construction techniques how the construction has been particularly done

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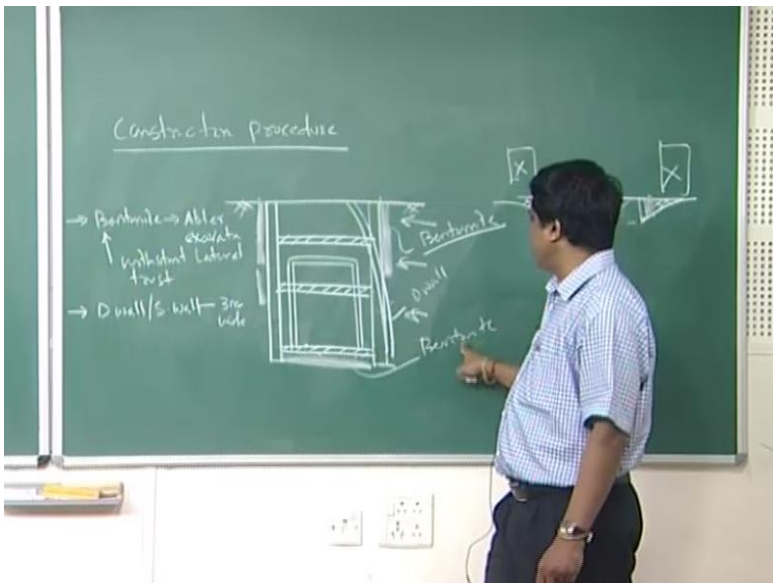

That will see here some of this is j construction procedure let us see these are all here walls along with the walls these are all your struts once excavation has been made these part has to be a made available. So, that some underground tall end or may be underground metro rail has to be provided how the construction is their techniques if you can i can write tables step by step after after why bentonite after excavation then d wall or seat pail wall it is would be minimum three meter white then your enforcement as here provided if we look at this construction.

Now, the construction has been started now the construction procedure if this my ground surface this is the ground surface is initially start this construction this construction to certain depth once we are excavation has done then what have been said by said provide you bentonite bentonite is a mixture of soil plus cement bentonite is a mixture of soil plus cement plus water with mixture of cement soil and water movement we do the r bentonite it will make slide soil hard it will make side soil hard. So, that by the time you instead set your diaphragm wall or sit pail wall. So, soil movement will be restricted so; that means, if i say this is my ground surface try to understand this construction procedure start first step of x are waiting initially we have to here is x of head.

Past we x of head after excavation it is not like to be a done immediately excavation

providing the diaphragm wall it takes certain time. So, what will happen these soil near by the soil there is a chance the ground movement will up because already this part of the soil here take can out this part of the soil below the ground of the surface has be taken out to prevent this what happen bentonite meets has been provided are both the ends of the exemption as it is a mixture of soil and cement and water. So, it will harden the nearby the part of the soil. So, it will. So, it will stop the ground movement nearby them what happen.

You insert your diaphragm wall then once you insert what happen the the construction then again start construction then again provide your write again provide your bentonite then provide your construction then provide bentonite you go up to till you want to go for your required depth than once we required to the depth achieve then provide you're the wall what will happen this struts with the provided regular interval because this bentonite a mixture is a they seatrains it handed over the period of time it may lose. So, what will happen then your provide your short term regular interval. So, that it prevail it prevail your one of these techniques that is lateral yielding it may possible because of soil because of soil pressure if you do not provide this struts if diaphragm may pail and seat pail all may pail means of bending to prevent this bending immediately after providing this d wall and pail walls you have to provide your certain regular interval

So; that means, in other way you are stopping this you are making his the wall to bed at the end at the end of the bottom at the bottom you have to again provide one struts that the bottom you have to provide the struts if u remember here then the chance the over button are increases there will be a bottom heaves. So, to stop that this bottom heaves if have to provide struts along with bentonite bentonite and what will happen use create a passage in between that underground construction can be take in hear once the wall is stubble the movement along the two sides it has been stopped. So, they are will not be a movement there will be not be a movement at the wall and it same time what will happen these diaphragm wall or the seat diaphragm wall it would not be bent.

It will be stubble. So, the construction space has been created. So, you go they are there we can do the construction for your metro rail and the other part of these things. So, this is your construction technique how you proceed step by step this bentonite provided means bentonite salary is basic aim it is for temporarily provided. So, that immediately before providing before providing you are the wall or the seat clay war the grounds

would not lateral movement; that means, the lateral movement of grounds would be prevented it is natural the movement you ground vertical, but are then what happen from the lateral site of the hopes

Once it will try to move this structure in nearby particularly metro city, it will get distances there will be may be a differential settlement may occur. So, to prevent before applying before inserting the wall then we go bentonite step by step bentonite then the wall then again construction go for bentonite, then provide (( )). Like this you reach your required depth once your reach your required depth, immediately to prevent lateral yielding of your walls you have to provides to at regular intervals. And once strut along with your bentonite, if have to do bentonite slurry by these bentonite this bottom part will be harden.

So, that the even it the lesser will be more, immediate the pressure will be more this would not and also some strut had be provided at the bottom. So, that it prevent he as well as lateral displacement of your wall. Once it is over then your space has been created for your underground construction. So, I will stop it here, then next class will start the design part of below braced excavation.