Application of Soil Mechanics
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Lecture – 13
Linear response; dispersion relation (path 2)

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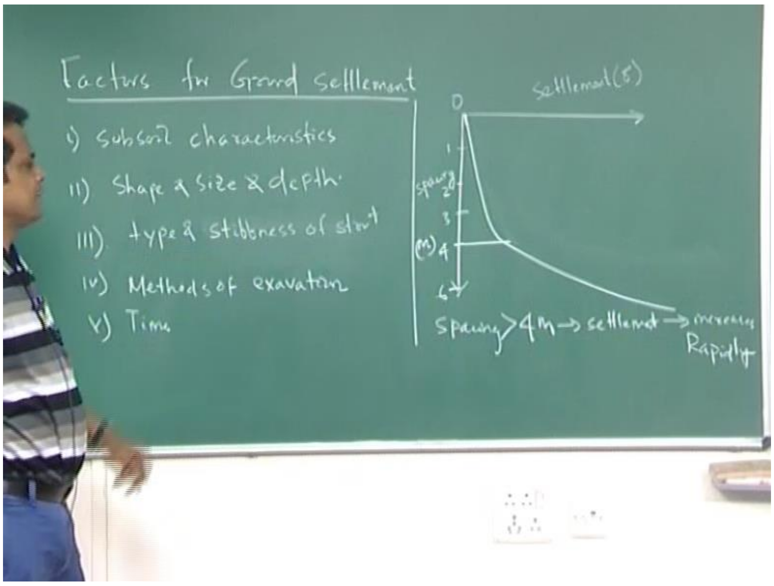

Last class we discussed factors for ground settlement, So, in these section soft soil characteristics one factor, then shape, and size, and depth, then type, and thickness sorry type, and stiffness of strt, then method of exvation. Now, off course last part is your of time now, if look at this these are the factor that I have discussed, and the last class what are the factors effected in the ground settlement, because this ground settlement is free requisite. Criteria are the ha existing structures are there so it should not happen that, because of ground settlement.

There will be any settlement in the existing structure. So, it depend upon your software characteristics; that means, as I said earlier it is either in soft soil or may be form soil or hot soil safe size, and depth your exavation how what is the safe, and what is the size, and how what is the depth exavation accordingly the ground settlement also increase, and decrease, and type of stiffness of strt a methods of service on a time. Now, if you come back to there are certain case studies in the Kolkata soil, if you look at these case studies in the Kolkata soil this is settlement delta, and this is your spacing.

And this start 0 1 2 3 4 may be 6 if you look at these experiment of investigation before stating of Kolkata metro rail Kolkata metro rail I best example, of underground Exavation or best Exavation in these case this example means there are experimental studies particularly, Kolkata metro rail means beyond a spacing beyond a spacing ha if look at here the diagram is slightly wrong, it is kind of a negligible beyond 4 meter of your spacing up this top the settlement increases very rapidly very rapidly this is an experimental investigation particularly Culcutta metro rail that means, in this case they have considered your spacing up to 4 meter; that means, they have taken up spacing 3 to 4 meter is recommended the spacing between 3 to 4 meter as been recommended as an optimum spacing as I said stiffness of the start.

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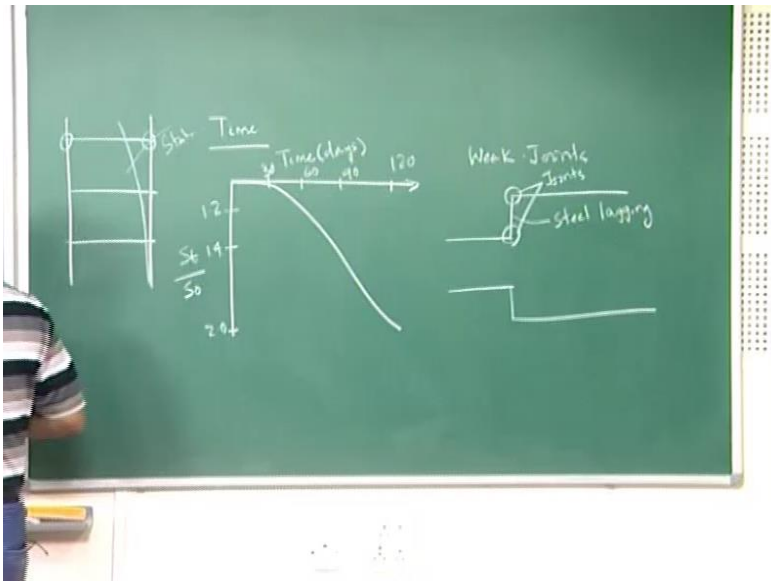

How what is the spacing should be there. So, that what should be the spacing if you look at here these are the strts these are all your strts. It will hold this particularly wall in vertical position; that means, how rigid this strts it depends upon what is your spacing what is your spacing between the strts. Now, particularly Culcutta metro they found that from experimental investigation if the spacing has been kept between three to four meter, then there is a less chance of lateral moment of your wall these are all case study may be it may vary from this is only for culcutta soil or culcutta metro for delhi metro this will be a different case study. So, these are all all depends up on your type, and stiffness of the strt it indirectly.

Depends on your house spacing, then from back to next parameter last one that is a time if you look at the time profile for the culcutta metro this is time in days final settlement by initial settlement thirty sixty ninety, then one twenty one point two one point four it goes up to say two point zero if you see look at this time in days particularly settlement it should be the construction should finish within the thirty days of time this is based on your case study of culcutta metro, if the construction finish within the thirty days of time that means settlement, less settlement will be encountered; that means, which settlement I am talking about ground settlement will be encountered everything should finish within the thirty days of time beyond this the settlement will be more it may possible for calcutta soil it is thirty days it may possible that for delhi metro it may be fourty fourty five days it it is varying from time to time before going this kind of structures particularly braced exvation these are the parameters important parameters you have to study first, then your based on this important parameter study. Then your recommendation will go and, then your design will follow, then it may possible that sometimes what happen there are during construction as I am going both two, and four means top bottom, and back like this time has gone, then now, method of exavation method of construction during the construction it may possible that there might be weak joints while construction care should be taken these joints should be leak proof the joints should not be like it, it is leaking it should be leak proof. So, because of this weak joints.

What is happen? There would be a leakage of water. So, by leakage of water once there is a leakage of water will starts what will happen the entire path will be it will broke down; that means, if there is a water flowing in this joint there is a leakage, so that means, it apply pressure to this wall once it apply pressure to this wall; that means, it will moving out moving away from this your fill. So, there will be a ground settlement. Now, if you look at that at the station. If I go once you are starting particularly at the station these are all called these are called joints this is called steel lagging. If I take this deck like a wall what will happen at station particularly when you start at the starting point at this station you need more weight you need more weight at the starting point; that means, at the station, because you have the construction work will start you need the more weight. So, to prevent that more weight you need to have you need to have your joints it should be water proof. So, there is a chance there is a chance that at the beginning at the beginning may be at the station point there will be a leakage it will start once there will leakage will start at the station point.

So, for this is your station point once there is a leakage will start what will happen, because of leakage this will try to twist this wall away from the fill. Once wall have been pushed away from the fill by means of water pressure, there will be a ground settlement, then come to next path this is all about your braced exvation in particularly clay.

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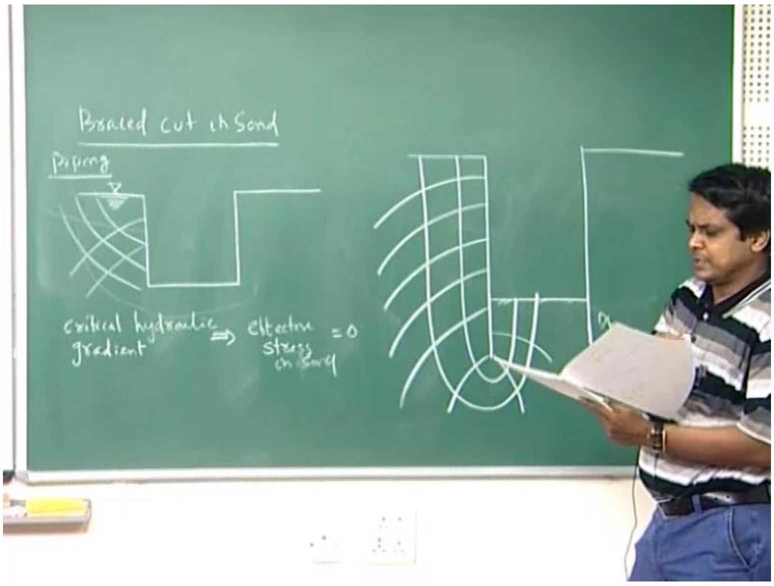

Now, braced exvation in sand or braced cut one phenomenon is called piping in. If you are doing a braced excavation particularly a sandy soil one phenomenon is called piping what do you mean by piping in piping hydraulic gradient critical hydraulic gradient critical hydraulic gradient under which under which particularly effective stress in sand is equal to zero effective stress in sand is equal to zero; that means, effective stress is equal to sigma minus u is your co water pressure sigma is your over bottom or vertical stress. So, with these sigma minus u co water pressure effective stress in sand is equal to zero how it comes particularly in how the piping will occur.

So, you start doing your flow net from the flow net what will happen how the drainage will occur the drainage generally excavation drainage will start from here to here. So, if I increase if I increase this particularly drainage path, this is your initial exavation of your diagram, and wall with this this is your flow net. If I increase the drainage path; that means, if I increase the drainage path suppose initially the drainage is going flow is going from here to here. If I increase the drainage path like this, then what will happen? The critical hydraulic gradient particularly the effective stress will not be zero. So, in that case, what suppose to be done there will be a the bottom you put some strt. So, that will be closed form, and this will act as cut of wall; that means, by increasing this drainage path the hydraulic gradient decrease critical hydraulic gradient will decrease; that means, it will be safe, but what will happen particularly in this there, if you look at towards excavations I put this wall up to this height. So, after suppose this is my requirement of this vertical excavation beyond this vertical excavation you extend this wall up to depth. So, what will happen instead of the flow is going. If you look at here the flows going like this look at the drainage path or may be look at the flow pattern here flow is moving from here to here is directly touching your.

Now, what will happen? I am increasing the drainage path from here how it is moving it is going around the pheri pheri, and at the bottom it takes; that means, these drainage path once it has been increased immediately your hydraulic gradient will decrease, then this will be safe particularly in case of sand. So, this is there are two cases particularly in this case there are two cases, and for culcutta soil generally it is given by, and others have given some certain design charts particularly in sand.

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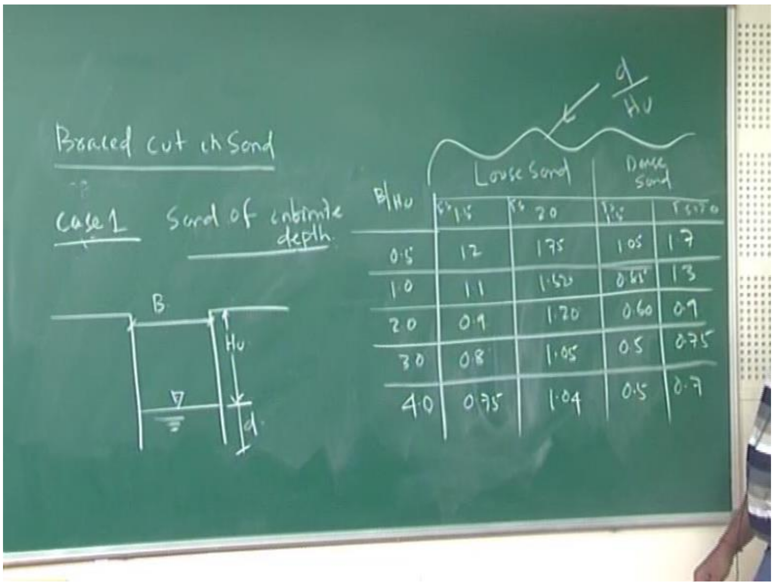

We will see case one, and case two case one sand of infinite depth what does it mean the sand is infinite depth; that means, the depth of the sand will be infinite. So, there is no finite below this the sand will be there up to infinite say fifty meter hundred meter there is no finite depth finite depth means five ten or twenty meter. So, in this case suppose this is my h u total height of excavation, and this is the depth below your height of excavation below this is the depth. So, particularly these case the design chart has been given it can be used directly there are two case one is the loose sand, and other is your dense sand. So, factors of t say one point five point two point zero one point five point two point zero dense sand factors of t say one point five factors of t is equal to two point zero. So, b by h u what is your b b is your width of your excavation h is your actual depth of excavation if you remember well earlier I have discussed this is my actual depth of excavation beyond this depth of excavation this diaphragm wall has been extended. So, that this increase your drainage path, so that means, so this is your b by h u. So, this is your zero point five for different b by h u zero point one two three, and four one point zero two point zero three point zero, and this is four point zero.

So, this will becoming one point two one point seven five one point zero five one point seven one point one one point five zero zero point eight five one point three for two zero point nine one point two zero zero point six zero zero point nine zero point eight one point zero five zero point five zero point seven five, then fourth point is zero zero seven five one point zero four zero point five zero point seven these values give you r d by h u d by h u means this d is unknown this d is unknown beyond this depth of excavation what should be your value of d I should go. So, that the critical hydraulic gradient will be less or minimum. So, that in this the drainage path will be more. So, this d has to be calculated. So, based on this experimental investigation, and others they have proposed this is your design charts for loose sand as well as dense sand taking factors of t one point five two point zero, and one point five point, and two point zero.

So, different value by b by hu suppose if I say b by hu is equal to zero point five; that means, b value of zero point five hu of zero point five one. So, it is ratio of width to depth ratio of width to depth for particular in that ratio of width to depth suppose we are taking a factors of suppose we are saying that I provide a factor of t of one point five, then what is the value of d by h u one point two. So, hu you know. So, d value will be two times of h u. So, beyond d it has to be extended. So, that it is should not piping effect should not occur in this case, now case two sand of finite depth case one is your sand of infinite depth. Now, case two will be your sand of finite depth sand of finite depth means after depth d where is your sand layer after depth b there is a sand layer of h one very close to your depth of excavation, that is why it is called sand of finite.

Depth that is why it is called sand of finite depth in this case in this case also they have given certain design charts those design charts are based on your experimental investigations. So, based on that the design charts have been arrived. So, if I take it b by hu.

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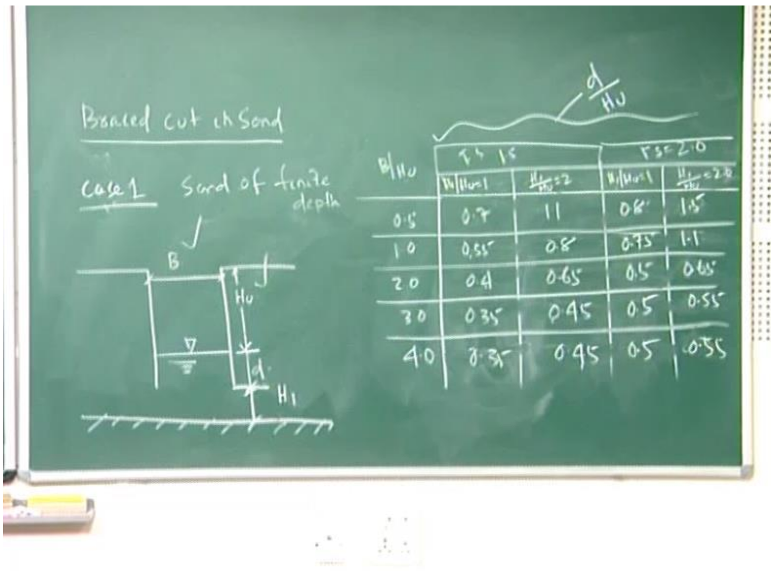

Suppose say this part I am writing h one by h u h one by h u is equal to one, then here h one by h u is equal to two, then in this case also h one by h u is equal to one, then h one by hu is equal to two. Now, this is for this is for factors of t say one point five this is for factors of t say two point zero, and these values are like zero point seven zero point five five let me write all zero point four zero point three five, and zero point three five one point one zero point eight zero point six five zero point four five zero point four five zero point eight zero point seven five zero point five zero point five zero point five one point five one point one zero point six five zero point five five zero point five five.

Now, these are values to find it out d by h u, other cases if sand of in finite depth in that case there are two cases considered one case is your for loose sand, and another is your dense sand, but sand of finite depth you are not consider in terms of loose or dense it has been puttered h one by hu h one below the depth of excavation, this is the depth of excavation below this extended depth of your wall, and below this at what depth this sand is there up to this sand layer is here h one by h u h is your excavation depth of your excavation it is one or two one or two. So, based on that there are different value of b by h u, then you can find it out once you know this is the given value b is given h is given once you know the b by h u value, then you can decide what value you are supposed to take h one by h hu is one or h one by h hu is two why there are two values have been given based on these the other factors of t has to be checked as I have discussed with your piping, and other if it is satisfiable from bottom any any possibilities other factors has to be checked based on these values. Suppose this h one by h u I equal to one, and b by h u is equal to zero point five with this you are getting d with getting this value of d suppose other factors of t are not satisfied what you are supposed to do either in case this value of d or if you are not increasing you can take h one by h hu is equal to two, then you check your other factors of t; that means, these are the range where factors of t other factors of t has to be satisfied. So, let us see one let us see one typical example before we go for a complete example we have to solve or complete problem of your braced excavation complete design problem.

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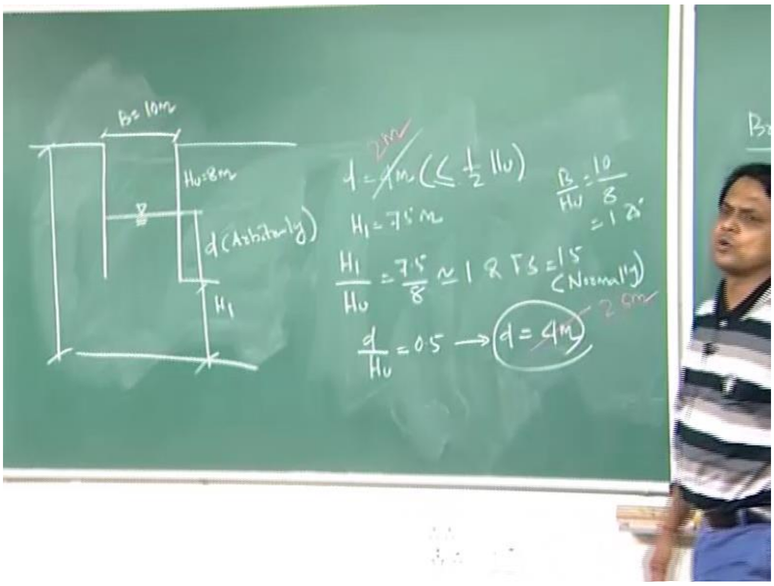

Now, this is the value of given say b is equal to ten meter h u is equal to eight meter, and d value is not given d either way either you choose d value arbitrarily arbitrary value of d or check. Whether the factor of t is coming within that range or not or you take that factors of t find it out your value of d. So, in this case d has been designed arbitrarily, and this is your h h one this is the finite sand of finite depth. So, let us say assume d is equal to assume d is equal to four meter, and how this d has been assumed this d has been assumed taking into consideration of less than half h u, if you start assumption of d, then it ted to value of d which should be less than half of h u less than equal to if it is eight meter. So, half of h u is less than to your four meter. So, b has been assumed is equal to four meter. So, h one h one also once d has been assumed this h one is equal to because this total depth is given.

So, h one also you take it seven point five meter. So, h one by h u which is equal to seven point five by eight approximately it is coming by one. So, from table h one by h u is equal to with your b by hu b by hu how much it is coming b is equal to ten by eight one point two or you can the value between one, and two these value, and find it out what is the values of factors of two. So, h one by h two is equal to one, and factors of t I am taking as one point five its generally normally we take factors of t of one point five, then b by h u is equal to one point two five, then from their once it is one point two five you find it out value of one what is the value of one what is the value of two how much it is increased, then for point two five how much it is increased, then you add it to your one one point two five. How this is this is the way you have to this value from this table.

So, once you get this one point two five factors of p is equal to one point five, then d by hu is equal to d by hu which is equal to zero point five; that means, d is equal to four meter now, in this case what will happen if you look at your in this case what is there I put arbitrarily value of d is equal to four meter means d value should be by the thumb rule less than or equal to half of hu I can take two meter I can take three meter with the assumed value of d you process the calculation, and take a factors of t of value one point five with this factors of value one point five find he value of d, if d is not coming with this value whatever the value d is coming next expression.

Suppose here I am taking, suppose here I am taking value of let us say d is equal to two meter. Now, here d value is coming. So, two point five meter; that means, those two are not matching, then next you take calculation d, and calculate like this you go both the d approximately should be matching whatever assumed whatever calculated, then this is your value of d once you get the d and, then afterwards you draw the, and check your other factors of t how it is coming whether it is satisfied or not well solve a complete problem in the next class two problems next or next class one is for other is for the sand.