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Geotechnical Engineering Laboratory
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Lecture No – 22
Consolidation

So you know for this particular loading.

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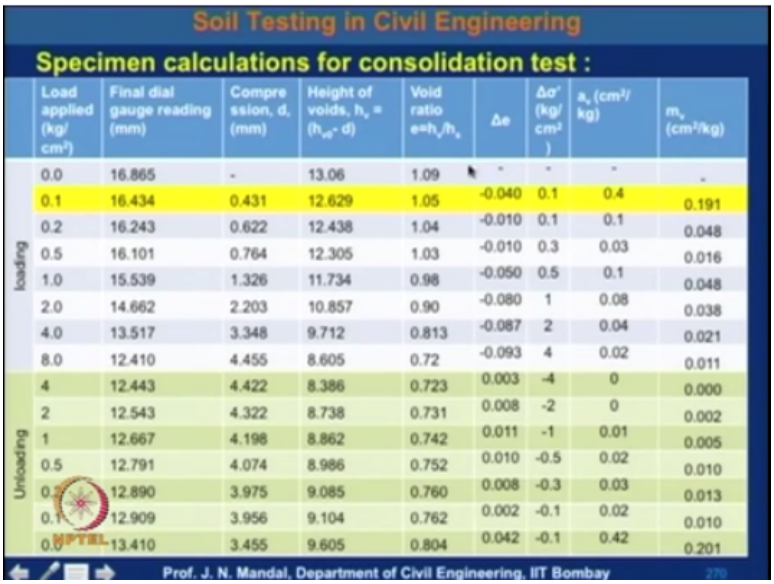

How to calculate the void ratio and how you can calculate the range of void ration and the A,B and the MB similarly you can calculate for different applied loading that mean in 0.2, 0.02 and then 0.6, 1, 2, 4 and weight so now we will draw the relationship between the applied load okay that is from 0, 0.1, 0.2 like that up to 8kg/ cm^2 verse that void ratio, so what should be the change

of the void ratio that means you know the void ratio we have calculated here the void ratio that is the e value.

So we know that what is e value so e value here is starting from this is 1.09 to up to 8kg/ cm^2 load is 0.72 okay so x axis's will be the loading from point 1, 2, 8 kg / cm^2 and correspondingly this void ratio will be from 1.09 to up to this is 0.72 so you can say this coloration and representing here in the form of graph so this is the load applied.

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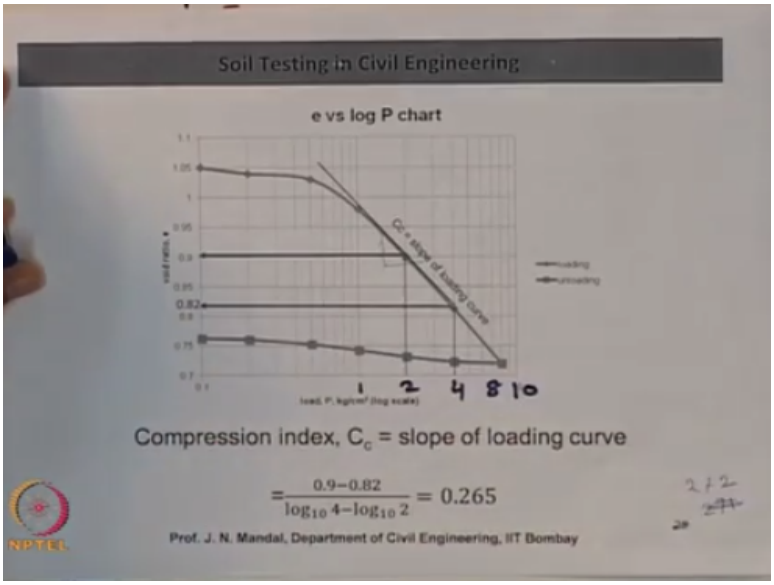

That is P kg/cm^2 this is log s scale, so this I say at 1, 2, 4, 8 like this, this is load in the x axis's kg / cm^2 load P is applied and this y axis's is the void ratio so void ratio is staring from here.

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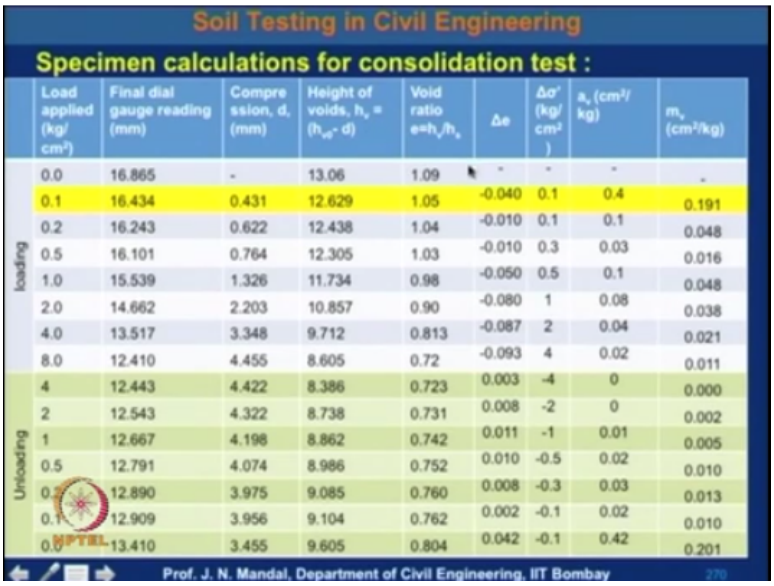

You can see that void ratio it is bases 0.72 and correspondingly load 8, then this void ratio correspondingly load this so like this up to 1.09.

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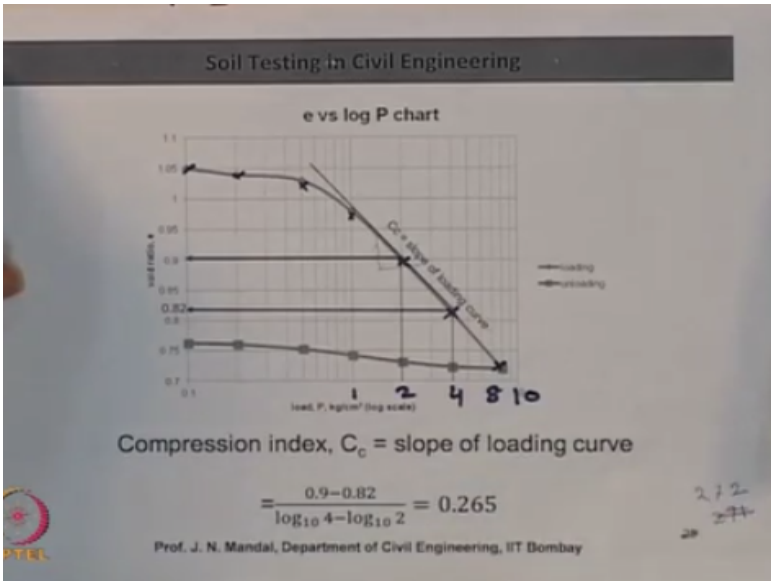

So this is 1.5 under the load of 0.1 so you know the load and you know what is the corresponding void ratio, so e can have this different point like this under different and so this is the load okay and this is the reloading card so when you are reloading.

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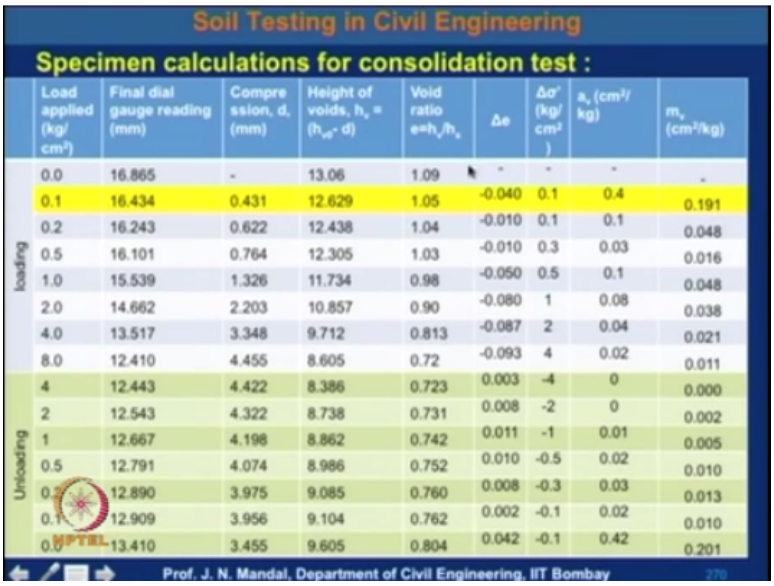

This unloading these again here that from starting from here it is here it is starting from this 4 to 0.1 and correspondingly void ratio so you have this curve.

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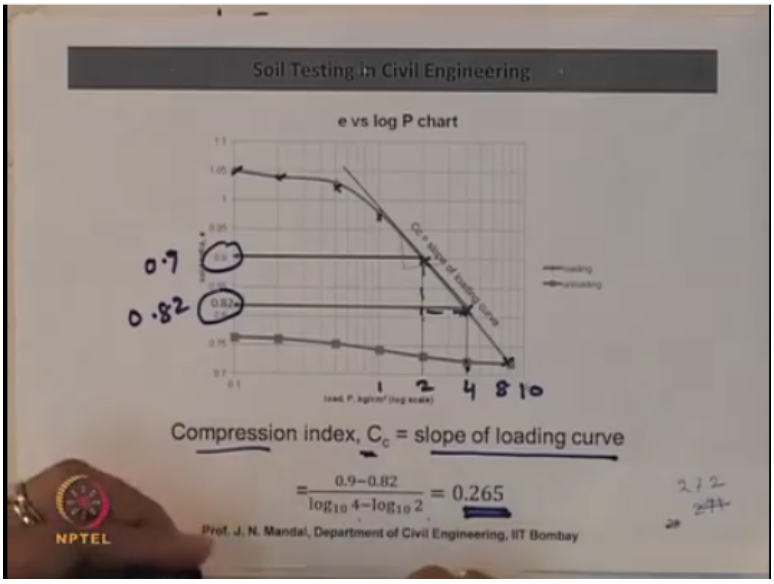

So you can draw the curve like this okay curve like this so this is the which you call the e log p curve that is e verse log P curve and from this e log P curve this part is the loading and this part is unloading okay so you can see from the e log P curve and this portion in the straight line, so you take a slope of this loading curve, so if this is the slop of the reading loading curve so this slope you can determine what is compression index so compression index that is designated as C_C okay.

This is compression index designate C_C – slope of the loading curve so you can see take this 2 point so when it is if you take this point and the void ratio is 0.9 here 0.9 this is 0.9 and when this value you have to take this point then your void ratio is 82 0.82 that means when you are taking that load is reload is 2 kg / cm^2 your having the void ratio value here it is 0.9 that is this is 0.9 so this is 0.9 and when the applied load is 4 kg / cm^2 and then you having this void ratio is 0.82 so you are writing 0.82.

This under the log of this is 4 – log of this 2 so if you calculate this 0.9 – 0.82 log of 4 – log of 2 is get this compression index that is 0.265 okay so from this e log P curve you can calculate that what will be the compression index and that is what is called the C_C this is important parameter to determine the settlement of any curve.

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I can show you here another table that is this is the elapsed time okay it is starting from 0, 0.25 to up to 400 40 that is minutes and this is root of t root of time so if you do the root of time you can have this value these are the further root of t okay and this is the load increment under that is 0.1 to 0.2 kg/ cm^2 so what are the reading similarly for this 0.2 to 0.5 kg/ cm^2 then 0.5 to 1 kg/ cm^2 what you dual gauge reading.

The 1 to 2 kg / cm^2 is called load applying then what will be the dual gauge reading and 2 to 4 kg/ cm^2 what is the dual gauge reading and then 4 to 8 kg/ cm^2 what are the dual gauge reading here from this table we wanted to draw the what should be the dual gauge reading and corresponding the time root t that is this is the dual gauge reading and this is the root of t value t time value that means we have to draw a correlation between the time and the dual gauge reading.

So here it is the dual gauge reading okay and here it is the root of t time, so I am saying that how you can draw a correlation between that time and the dual gauge reading.

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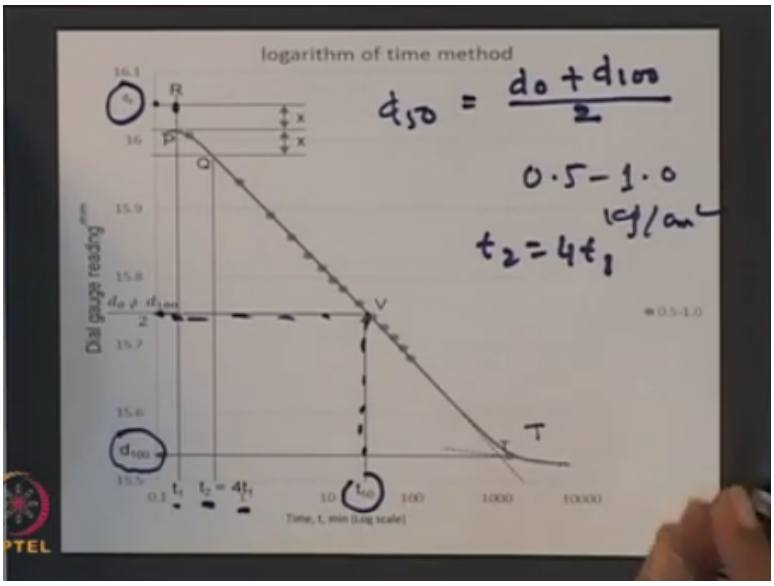

So here the time x axis's is the time so this is the time okay and this is the dual gauge reading this is log time in log s scale okay and this the different dual gauge reading so you know that what should be the dual gauge reading you know is the time so correspondingly you can draw this curve so this curve will be like this okay, so this is call the logarithm of time method from the logarithm of time method how you can calculate that what will be the degree of consultation and this logarithm time method for a loading of 0.5.to 1 kg / cm^2 under this loading.

So this curve is 0.5 to 1 kg / cm^2 under this loading what will be the time that is t in minutes and this dual gauge reading you can draw a curve line that so you have to calculate that what should be the coefficient of consolidation that is logarithm of trim method, so form this curve you know this is the dual reading and this is the time in the log scale so you plot the dual gauge reading verses time curve on a similar graph paper first.

And then secondly you choose plot P and the Q, P and Q on the curve corresponding to time this is t1 and this is t2 such that t2 will be equal to 4 of t1 so t2 will be equal to 4t1 so you have to choose the point P and Q if P is t1 and Q will be t2 will be equal to 4 of t1 now differences is number 3 the difference between this dual gauge reading corresponding to P and the Q let us say is x here which is being and x if it is a x mark a point R here mark a point R okay here such that P of R is equal to x that means P R = x.

So P Q = x and PR = x so dual gauge reading corresponding to R this R each d_0 so it is called d_0 this d_0 okay and this d_0 is for 0% consolidation now fourthly you draw a tangent to the curve here

you can see curve is like this so you draw a tangent on curve tangent on the curve and intercepting at the point t here is the t point at the point t and corresponding dual garage reading here that is d of 100 and this reading d 100 corresponding to 100% consolidation so here it is the 0% consolidation d_0.

Here it is the 100% consolidation by the logarithm of time method you can determine that 100% consolidation apart from this 100% consolidation you can also draw for the 50% also consolidation that means you can also calculate what will be the d of 50 okay so d of 50 will be equal to d of 0 + d100 this divided by 2 okay so that means we know d0 you know d100 so d0 / d100 / 2 that means it is the 50% that means time is equal to t 0f 50 and correspondingly you can calculate that what will be the 50% also d of 50 we can calculate. So from this curve you can calculate that what should be the coefficient of consolidation.

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So coefficient consolidation that is call the c of v so have to calculate that c of v so C of v you know that.

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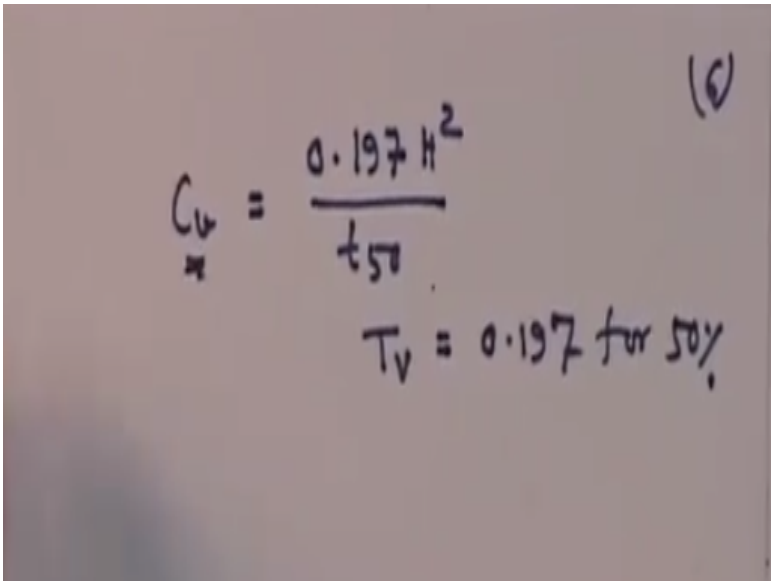

Earlier we have discussed this coefficient of consolidation is 0.197 in H^2 this divided by t 50 let us say for 50 and for the 50% consolidation then Tv value = 0.197 so you know what Tv 0.197 for 50% consolidation and this t 50 that time okay for 50 so from this data you can calculate what will be the coefficient of consolidation you know that height you know that what is t 50 which we can determine time so you can calculate that what will be the coefficient of consolidation from this time logarithm plot okay. So you can calculate, now this is one method to calculate the coefficient of the consolidation.

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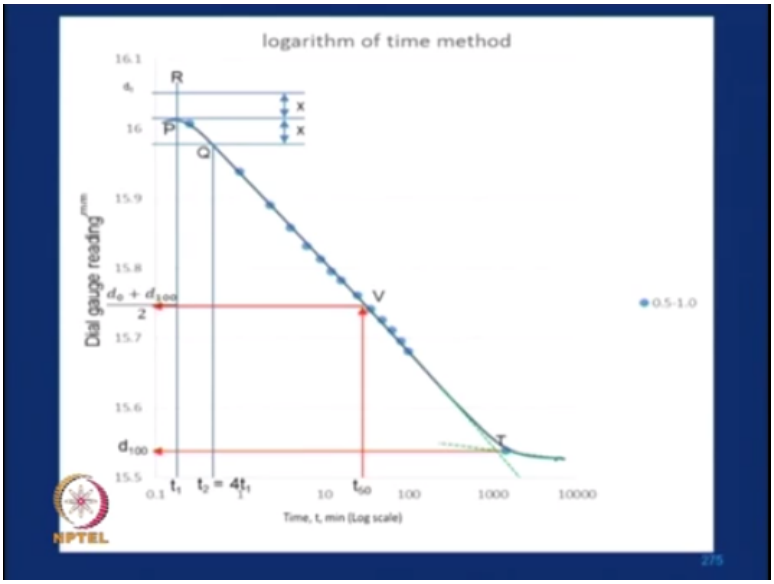

Now you can draw the square root of time method this another method okay you have to calculate the coefficient of consolidation by square root of time method.

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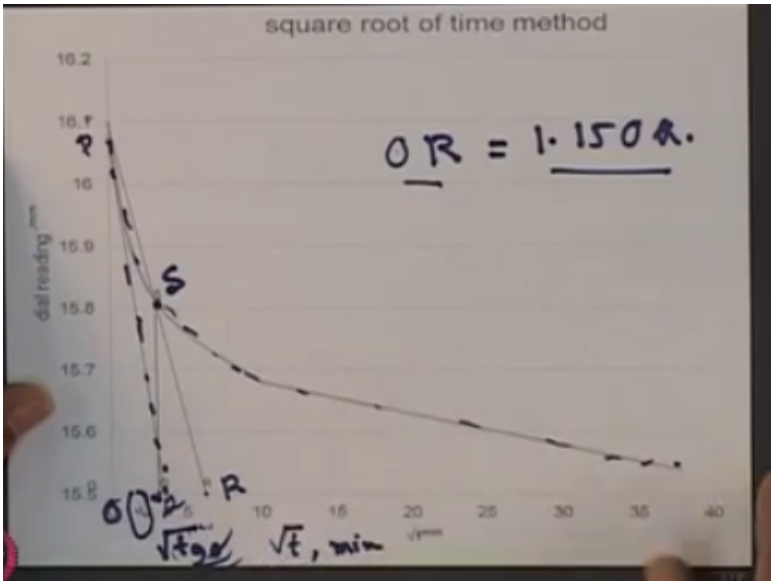

So here this y axis is the dual gauge reading and x axis is the root of t in minute this is root of t this is in minute so from the plot or table so I have shown you what is root of time that is 0, 5, 10, 15, 20 , 35 etc and correspondingly dual gauge reading so you know the what you target region so you can draw a curve is like that this is for the course square root of the time fitting method, so what the dual gauge verse square root time curve on a graph now draw a tangent okay this tangent you draw a tangent that is P and Q this is Q and this is P.

So the curve is like this okay and you draw a tangent like this that is P of this is Q okay this is P, Q and draw another line this is P and this is R another line starts that this OR will be equal to 1.15 of OQ that means this will be O of R will be equal to 1.15 O of Q that means this is O OR will be 1.15 of O of Q so mark this point is this is the s where PR intersect the curve and S is of the S this axis are of the S okay where the PR intersects the curves so axis of the S give the her axis of the which will give the t of 90 root of t 90 so this give the root of t of 90 okay.

So then you can calculate that what will be the coefficient of consolidation from the square root of time method we can calculate for the root of t 90 okay.

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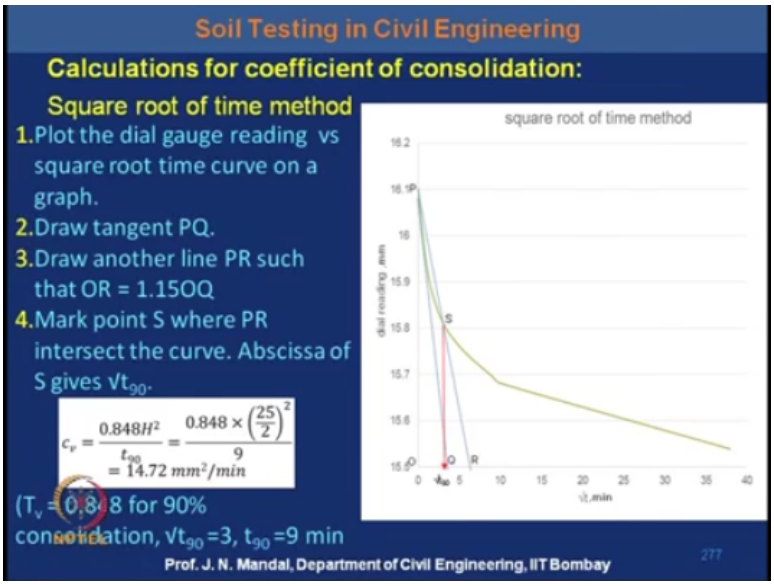

So how to calculate the coefficient of consolidation for 90%, degree of consolidation.

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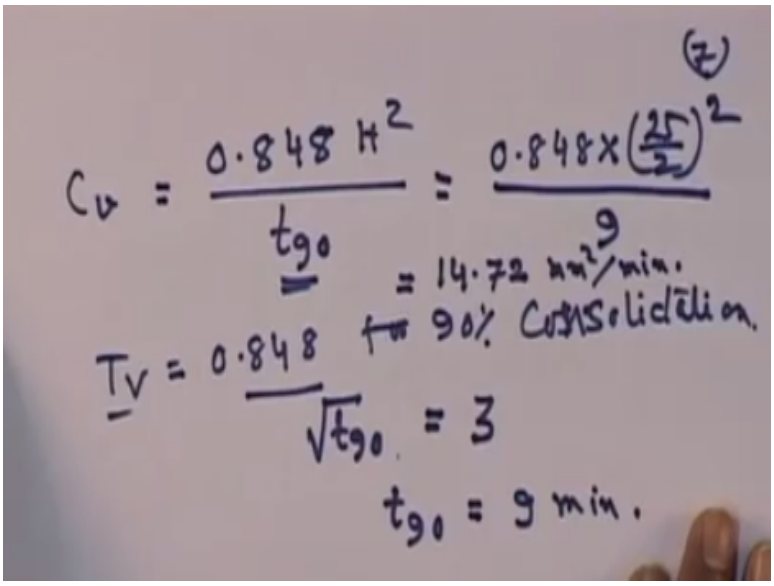

So we know this coefficient consolidation this is 0.848 x H^2 / t90 okay so you know this is 848 that is tb = 1you know that tb = 0.848 for 90 % consolidation okay these value you know and you have to calculate that what should be the corresponding of t of 90 okay so then you can calculate the what is t 90 so first you can calculate that coefficient of consolidation let us say that height of the sample is 25 so this will be equal to 25/ 2 this is both way then is and this divided by we have to calculate what is t 90.

Okay so root of t 90 you can have this value is about 3 so t 90 value will be equal to 9 that is minute so t 90 value will be equal to 9 here so from this equation you can calculate the coefficient of consolidation about 14.7 to this is mm^2/ min okay so we can calculate the 90% consolidation so from this square root of time method you can calculate the 90% of consolidation what else that earlier I showed you that method you can calculate the 100% degree of consolidation 50% degree of consolidation okay Now how to calculate the pre consolidation pressure okay.

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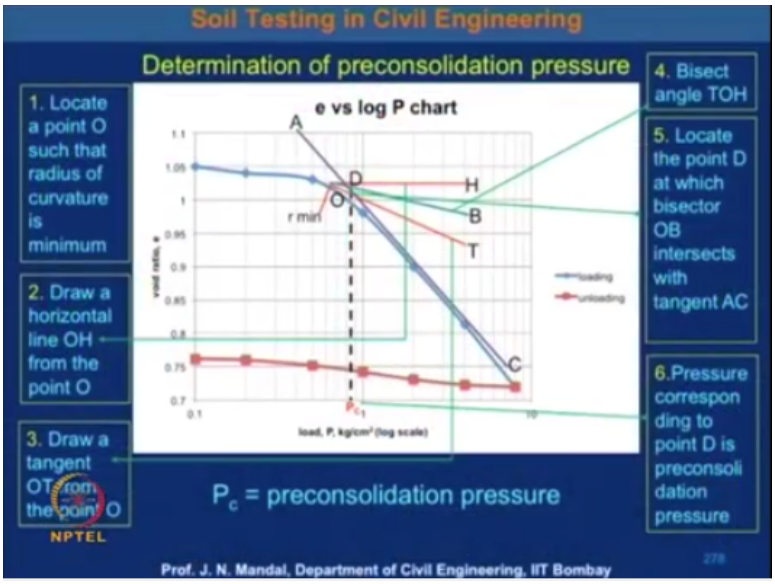

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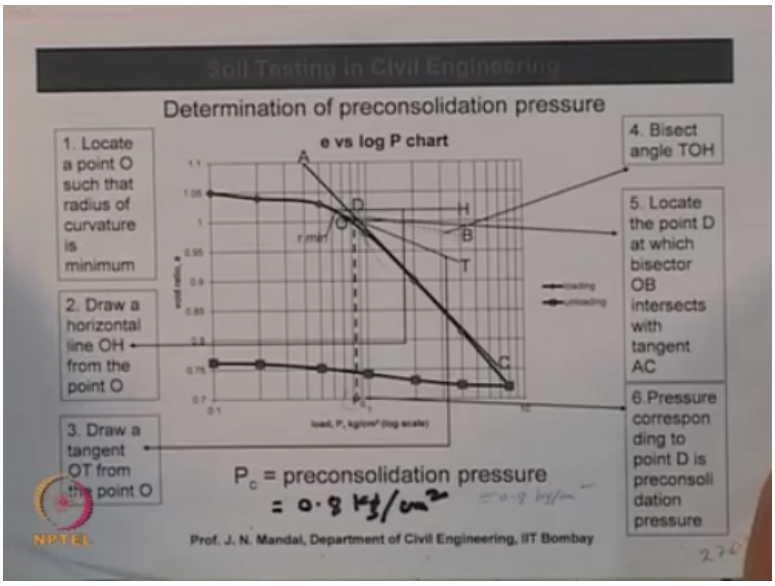

So this is the curve which is the curve which you called e verse log P so x axis is the log P that is load applied in the log scale and kg/ cm^2 that is 0.1 this is 1 to this is 10 and this is the void ratio that is e so form the earlier table so you can draw that e log p curve this is the curve tit is like this the curve this is like this unloading this is loading and then it is the unloading curve so you can have a curve like this okay so this all the void ratio verse load curve in the log s scale so you have to determine that what will be the pre consolidation ratio so first you can see the curve is like this first you locate the point O here such that radios of the curvature is minimum okay.

And then you draw a horizontal line to draw a horizontal line okay OH from the point O we are dawning horizontal line and draw the tangent that is O T either tangent from the point O and then you bisect the angle TOH you bisect the angle and locate the point D at which bisect OB look at this point bisect OB intersect with the tangent this is the tangent AC okay then the pressure corresponding to the point D is call the reconsolidation pressure.

So from this curve you can determine that P consolidation pressure so you know that how to calculate the P consolidation pressure and P consolidation pressure is designated at that P of C and here that P consolidation pressure is somewhere here okay so this is 0.1this is 1 so here p consolidation pressure is about 0.8 kg/ cm^2 so we can write that P consolidation pressure is equal 0.8 kg/ cm^2

So in this consolidation test so we can determine that logarithm that square root of time method logarithm method or the determination of the coefficient of consolidation and you can also

determine that P consolidation pressure so this consolidation chapter is very important so we have leant how to have to take the reading dual gauge reading or the different timing under the different loading of the load is increment it goes up to the 49 40 minutes and again you go for incremental loading and it continue like that okay.

And from the dual gauge reading time method you can calculate that part should be the void ratio you can calculate the what will be the change of void ratio you can calculate the what is the AV you can calculate the what is the MV and form this table you calculate that what is either relationship for the e and log P and how to calculate that compression index that is TC and apart from the C_C from the curve that is load verses the time or the dual gauge reading you have also can calculate that part will be the degree consolidation okay.

Under the two verse style and you also can calculate that P consolidation pressure that is void ratio verse the log of P curve and you can determine the P consolidation pressure so now you have an idea in the consolidation that how you can determine and then how we can also calculate the settlement and also you can calculate that what should be the coefficient of permeability and coefficient permeability can be determined by the consolidation test even indirect method.

But if you know that what should be the void ratio what should be the C_C value compression index value and then you can also calculate that what will be the settlement and in this consolidation chapter because settlement is very important you know the settlement equation and from this consolidation test may though you can determine that what is the compression index that is C_C you can determine the what would be the void ratio and you know that under different loading then you can calculate the what will be consolidation settlement of the soil apart from consolidation settlement you can also determine the P consolidation pressure thank you.

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