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Geotechnical
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Laboratory

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Lecture No – 17

Shear Strength

Now I will discuss consolidated gent axial test, after proper in casing of the sample in that axial cell they require little pressure if applied. Now then involve is kept open one on application of the lateral load the excess hydrostatic pressure start to dissipate slowly thereby causing a volume change.

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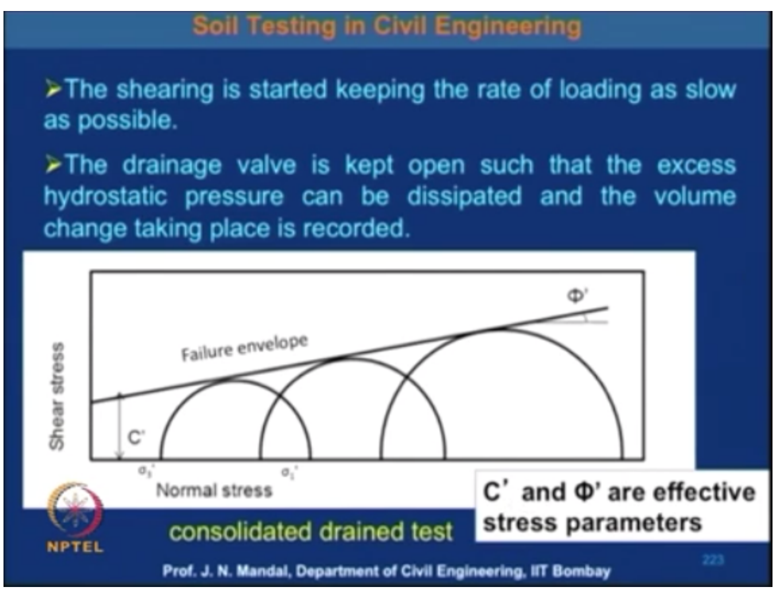

Now shearing is started keeping the rate of loading and slow as possible the drainage valve is kept open such that excess hydrostatic pressure can be dissipated and the volume change taking place is recorded. So here it is the result for consolidated dentist. So yet the shear stress versus normal stress relation and this is the more circle and in case of consolidation dentist and this is the failure envelope you can see here in case of consolidated dentist you can measure what should be the cohesion value that is effective cohesion and you can also measure that what will be the effective angle of shearing resistance that is ϕ'. So from the consolidated dentist if you can measure the C' and ϕ' which are the effective stress parameter.

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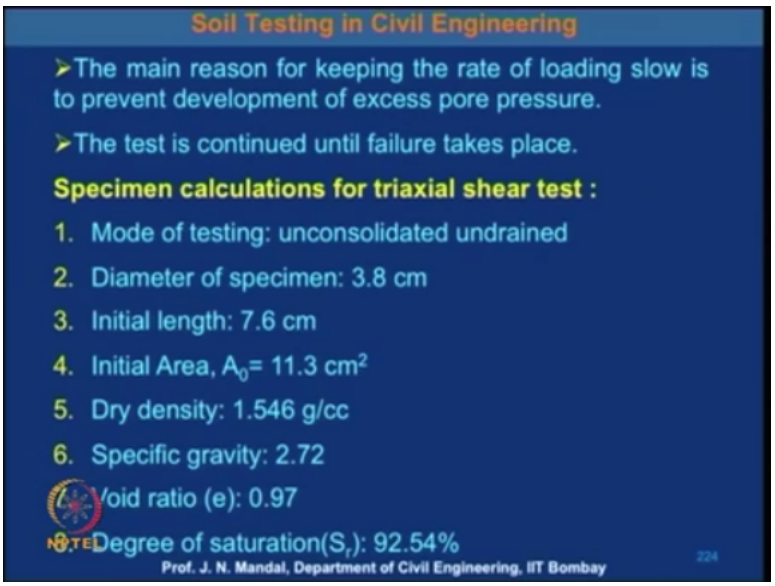

Now the main reason for keeping the rate of loading slow is to prevent the development of excess pore water pressures. And this test is continued until failure take place, I just see some specimen calculation or tri-axial shear test.

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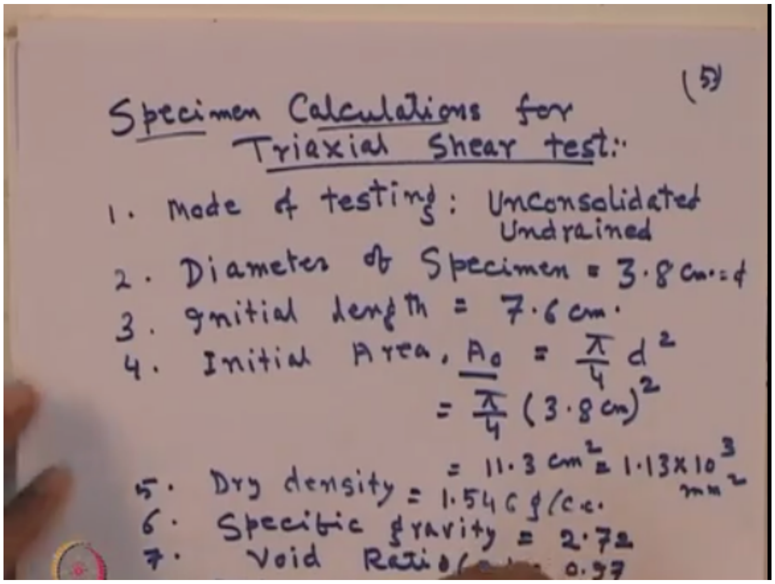

So this is the specimen calculation for tri-axial shear test. So first that mode of testing, mode of testing that is unconsolidated undrained test. Now you know the diameter of the specimen is equal to 3.8cm and next initial length of the sample is 7.6cm. Next initial area that is A0 = Л/4 into let us say d^2 if d is the diameter of the specimen if this is D. So you can write Л/4 3.8 this is cm, this is square you can have $11.3cm^2$ or $1.13x10^3$ this is mm^2.

So you can determine that what will be the initial area. So know what should be the dry density you can calculate the dry density you know how to calculate dry density, dry density is equal to 1.546g/cc you know how to calculate that specific gravity we have already covered this is 2.72 and you know void ratio, and void ratio that is designated at E = 0.97 and the degree of saturation, degree of saturation that is designated at SR = 92.54%.

So you know this all this or this data what will be the diameter of the sample, what will be the area of the sample, what will be the dry density, specific gravity etc. So these tests are to be performed under the different loading so this is unconsidered and in test. So if you measure the deformation.

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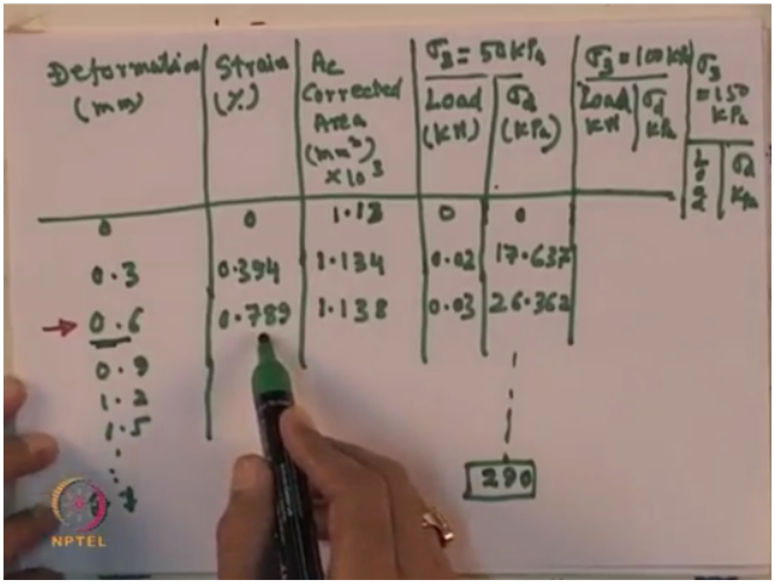

That is in millimeter you measure the strain that is in percentage and then you measure the, if that is corrected area you see the corrected area okay, this is mm^2x10^3 and then you are measuring added different confining pressure σ C is equal to let us say 50 kilopascals. If you know that what will be the load under this confining pressure that is kilo Newton and what should be the deviator strain this is D the deviator stress that also in kilo Pascal. So like this you can also, the another confining pressure that is 100 kilopascal what should be the load kilo Newton, load kilo Newton and the σDKP debia distress, and similarly for another confining pressure is 150 kilo Pascal.

So you can determine what should be the load and also you can calculate what will be the σ D that means deviator strain that is KP. So under different confining pressure or self measure it may be 50, it may be 100 kilo Pascal, it may be 150 kilo Pascal. Let us say that deformation is this is zero, and strain is also 0 and initial area which we calculated earlier that is 1.13 initial area which we have calculated earlier.

And then load is equal to 0, then σ load here is equal to 1.1 say this is 0, this is also 0 in the beginning I am just showing only for the under the confining pressure of Σ3= 50 kilo Pascal. Similarly you can also calculate for the Σ3=100 kilo Pascal as well as Σ3=150 kilo Pascal, I am just focusing here only for the 50 kilopascal okay, you can let us say measurement for this deformation is 0.3 just say 0.6 you will have some data. So 0.3 let us say the strain value is 0.394 is the corrected area you can have 1.134 and the load is 0.02 and the deviated strain is 17.637.

Let us say for a deformation of 0.6 the strain value is 0.789 and corrected area 1.138 and to load is 0.03 and the σd that is deviator stress is 26.362. So I will just focus that how you can calculate this deviated for a particular deformation 0.6, how we are measuring the strain then corrected area and for the confining pressures of σ3 what will be the load and what will be the deviator stress.

So like this you can continue with the different deformation it will be the 0.9, 1.2, 1.5 and you continue like this deformation you continue until you can have some maximum value okay is continue like this any deformation value, it maybe 8.7 etc., like continue. So you can have some maximum value, so you will be knowing that what will be the maximum value that deviator stress maximum value for the 50 kilo Pascal.

So let us say that you are having that maximum value let us say 200, 290 okay for a particular deformation of 8.1. Similarly you can have that what will be the maximum deformation under the confining pressure of 100 kilo Pascal, and what should be the maximum deviator stress for a confining pressure of 150 kilo Pascal. Now I also hear that for this deformation how we are measuring the strain.

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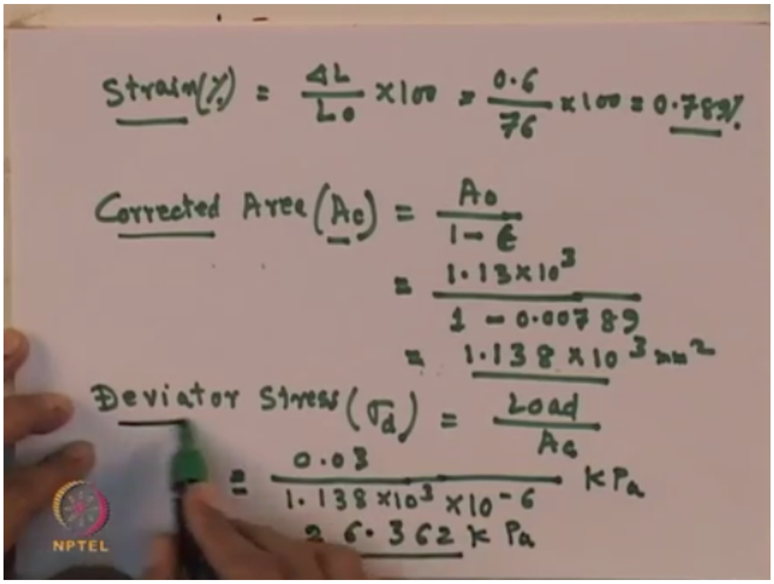

So strain can be in terms of the percentage that is ΔL/L0x100, so what is ΔL, because your deformation is 0.6. So 0.6 deformation this divided by I say the length of the sample as I told you earlier that is 7.6cm or here it will be the 76m. So this is the initial length of the sample this into 100 so you can have this value it 0.789%.

So you are having the strain value of 0.789, so here you can see for this deformation this strain value is 0.789 okay. Now we calculate the corrected area that is SE, let us say that corrected area that is designated at AC you know that is A0/1 - this is Σ okay strain. So what is A0, A0 we have calculated earlier that A0 is $1.13x10^3mm^2$. So we can write $1.13 \text{ x } 10^K$ this divided by 1 –Σ that means Σ= we have already shown you this Σ value and that value is this strain here 0.789.

So in percentage it will be the, this is 0.789 so in percentage it will be the 0.00789. So if you calculate this, so you can have the corrected area will be about $1.138x10^3$ this is mm^2. So you are having the corrected area AC = $1.13x10^3$ which is only in this table that corrected area that is AC corrected 10^3 $1.138x10^3$. So you determine that what will be the corrected area. Next I will show you how to calculate the deviator stress okay.

So deviator stress it is designated as σd this deviator stress is equal to load divided by Ac that is corrected area. So what is the load, so when the load is applied 0.03 okay, so load is equal to 0.03 this divided by Ac that is the corrected area. So corrected area we have already calculated and shown in this table $1.138 \text{ x } 10^3mm^2$, so we can write $1.138 \text{ x } 10^3$ this is mm^2 and this into 10^{-6} we are expressing in terms of kilo Pascal okay.

So we are having the deviator stress if you calculate we can have this is 26.362 this is kilopascal. So we are having the deviator stress σd = 26.362 kilo Pascal. So here table we are showing the deviator stress σd = 26.362 like that for the different deformation you can calculate that what will be the deviator stress okay.

That is σD, so at a particular deformation you can have the maximum value of the deviator stress let us say that maximum value is equal to 290 kilo Pascal under the confining pressure when $\sigma 3$=50 kilopascal. So we are having that when the confining pressure let us say that confining pressure is.

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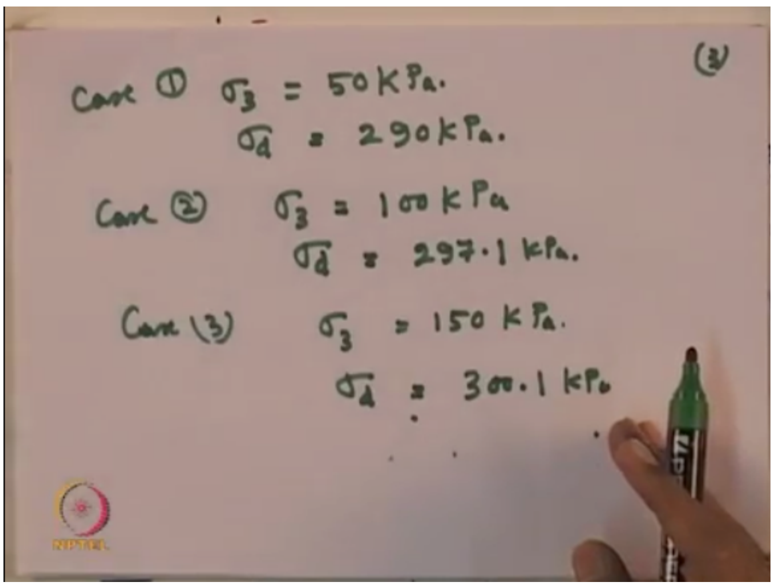

When the confining pressure that is $\sigma 3$ = 50 kilo Pascal we are having the maximum deviator stress in kilo Pascal you are having the maximum diameter stress 290 kilo Pascal okay. Similarly when the confining pressure is 100 kilo Pascal, then you can have the deviator stress value. Let us say this deviator stress value is 297.1.So for let us say first case this is the case one and this is the case two, then the confining pressure is 100 kilo Pascal, so we find the deviator stress is equal to 297.1 kilo Pascal.

Similarly, for the confining pressure when $\sigma 3$ = 150 kilo Pascal you can have that maximum value of derivatives here let you say 300.1 kilo Pascal. So we can write in case three that when the confining pressure is equal to 150 kilo Pascal, so you can have a deviator stress is about 300.1 kilo Pascal.

So under the different confining pressure so you can determine that what will be the deviator stress, that is you know now what will be the deviator stress. And you can also draw that deviator stress versus the axial strain curve under different confining pressure. So how you can draw the curve in between the deviator stress and the axial strain under different confining pressure.

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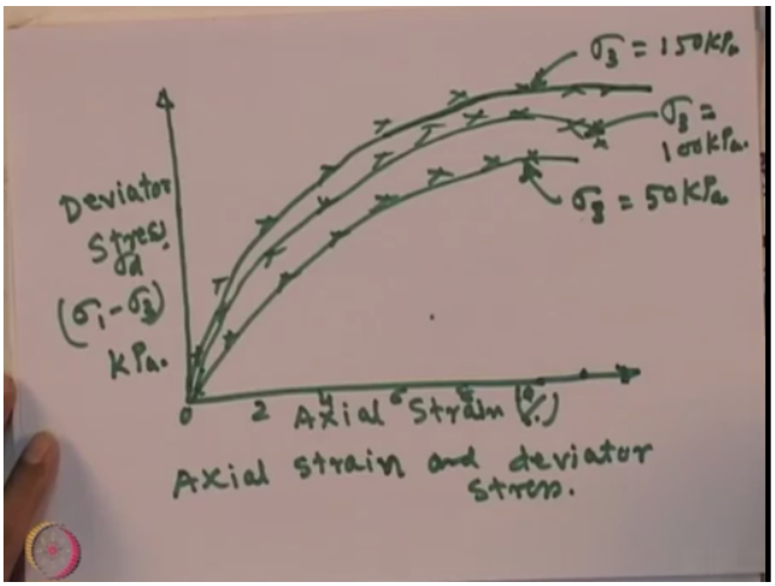

Suppose if you draw a line like this the axial strain, this is axial strain okay that is in percentage and this is the deviator stress and that is σ1 - σ3 we say σ-σ3 or you can say σd and that is in kilo Pascal. So this under defined axial strain this value may be 2, 4, 6, 8, 10 like this 12. So from the table you know what will be the axial strain which is known to you the axial strain value and now what will be the deviator stress.

So for a particular strain you can have a deviator stress okay. So you can have some point like this for a particular that cell pressure or confining pressure when σ3 = 50 kilo Pascal. So this is the relationship between the axial strain and the deviator stress. So this is for a particular confined pressure of 50 kilo Pascal.

Similarly, you can have the another curve it may be like this okay for a confining pressure of σ3 = 100 KPa you can have like this curve for 100 KPa, you can add discuss for the 50 KPa, you can have the another cut may be like this. So this is for the $\sigma 3$ = 150 KPa. So you can draw this free curve under that define confining pressure, so confining pressure is increasing the deviator stress also that increasing.

So you find from this test you can draw a correlation between the axial strain and the deviator stress, this is very important parameter in tri-axial, how you can determine the deviator stress and the corresponding strain, because you should know what should be the strain is required and corresponding what value is to take into account for the deviator stress and also equally under you can also express this curve in drawing the most circle diagram and because you know that what should be the initial than normal stress.

And what will be the final normal stress, so you can draw a correlation between the between the shear stress and the normal stress. So between the shear stress and the normal stress you can draw in number of the Mohr circle, you can draw the Mohr circle envelope and also you can determine what should be the shear strain parameter C and ϕ and which we will explain in my next lecture thank you.

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