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NATIONAL PROGRAMME ON TECHNOLOGY ENHANCED LEARNING

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Geotechnical Engineering Laboratory

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Lecture No – 16
Shear Strength

Welcome, I am Prof. J. N. Mandal, department of civil engineering in an institute of technology Bombay. So I will now discuss the procedure of the test, first the proving ring is attach to the cross set of the frame any other necessary extension pieces and the upper pattern is fitted securely to the lower end of the ring. The dark edge is secured and checked ensuring that the end of its stream makes contact with adjustable stock on the name.

The lower pattern is adjusted to provide the space to insert the specimen; the strain rate is said to 1.5 mm/min on loading machine, the state specimen.

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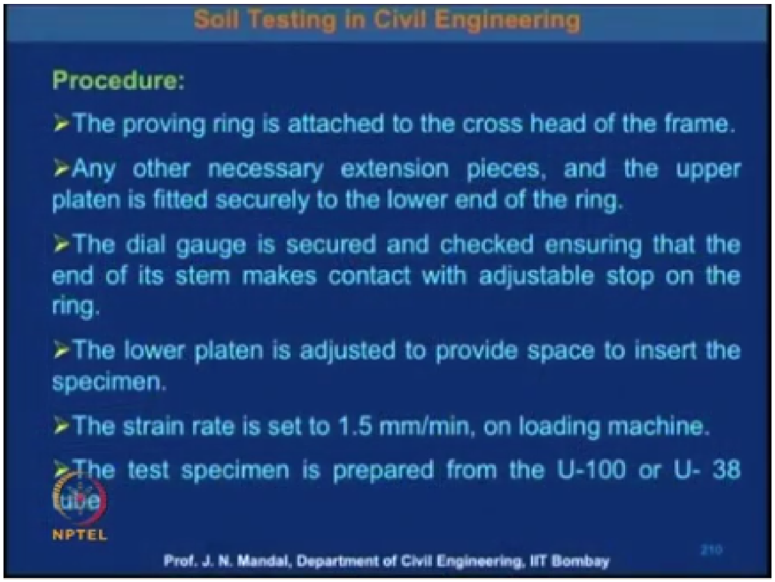

Is prepared from the U-100 or U-38 tube.

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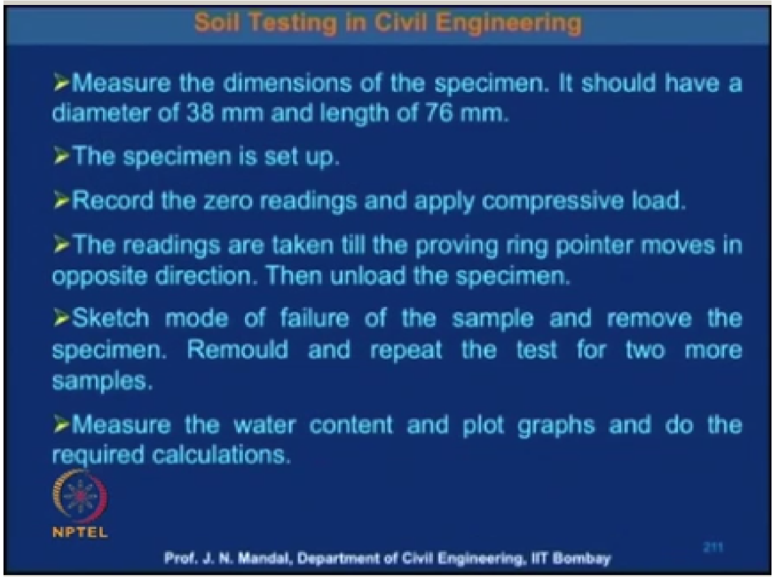

Measure the dimension of the specimen; it should have a diameter of 38mm and length of 76mm. If the length is 76mm then diameter will be half of the length that means 38mm, the specimen is setup. Record the zero reading and apply the compressive load. The reading are taken till the proving pointer move in opposite direction then unload the specimen. Sketch mode of failure of the sample and remove the specimen, remould and repeat the test for two more sample. Measure the water content and plot graphs and do the required calculation.

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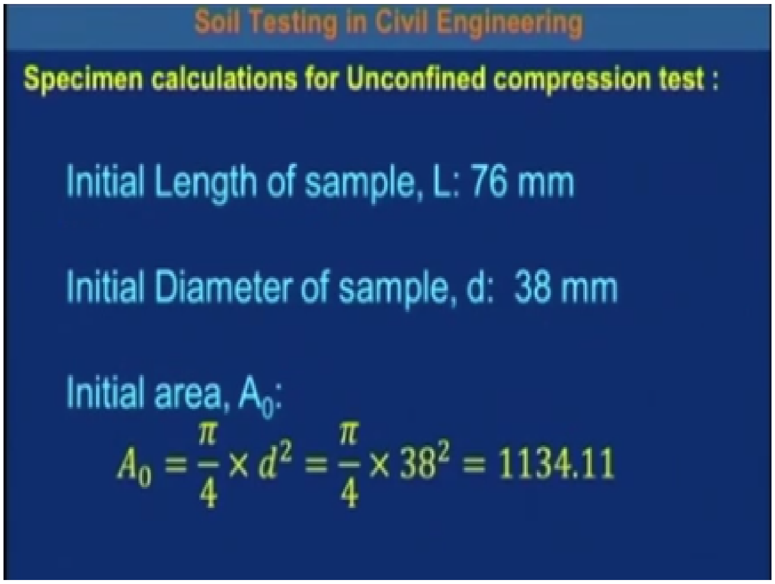

I will now show you that how we can calculate the specimen calculation, so this is the specimen calculation for unconfined compression test.

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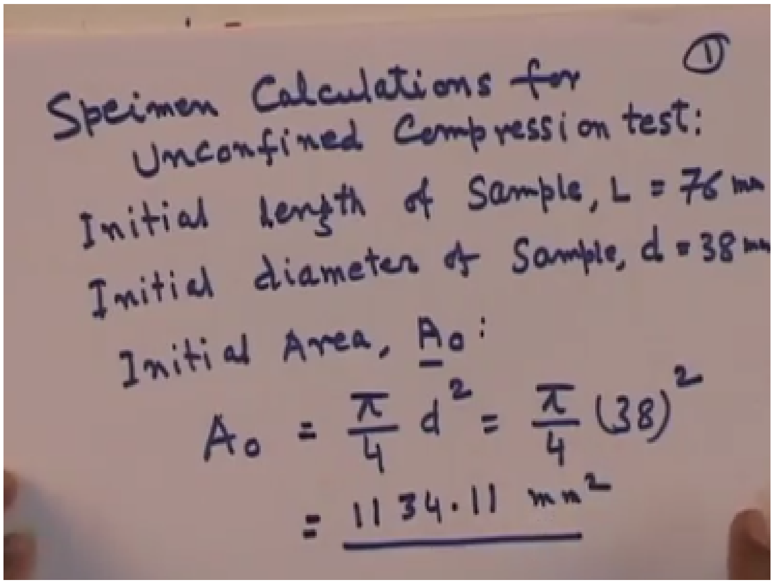

So we know that initial length of sample that is L = 76mm and initial diameter of sample d = 38 mm so we can calculate that what should be the initial area and that is designated at A0 so A0 can be calculated at A0 = Π/4 d^2 or Π/4 and d mean 38 so 38 mm^2 so if you calculate we can have the initial area A0 will be 1134.11 this is mm^2 so you can calculate that what should be the A0 that means initial, initial area of the sample. Now I will show that how to take the reading or unconfined compression test.

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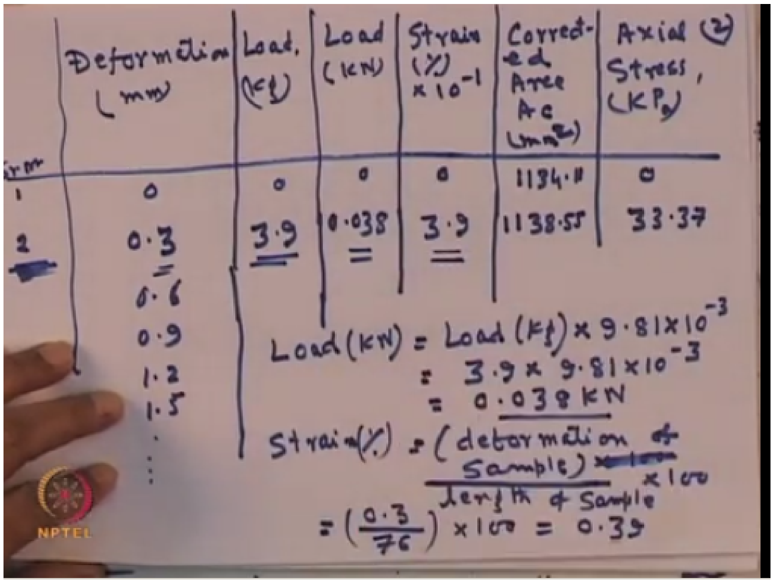

So first of you can measure the deformation that is in (mm) then calculate what will be the load in (kg) then you calculate the load in (KN) then take the strain value that is in percentage this include 10^{-1} and then you can measure the corrected area that call S this is mm^2 and then you can calculate that what will be the axial stress that is (KP_a) okay. So initially that is or this is 0000 and corrected area may be 1134.11 this is initial area.

But I shown you earlier by calculation then axial state is 0, so this is you can I just real number the second case you are measuring the deformation of this sample let us say deformation = 0.3 and load = 3.9 kg and load in KN will be 0.038 then strain is 3.9 and collected area you can have 1138.55 and the axial stress = 33.37 so you have to continue like this different that deformation in may be the 0.6 it may be the 0.9 or it may be 1.2 okay 1.5 like this you can continue, okay.

You can take the reading and can continue this under different deformation you will have the load in KN strain and the corrected rate I am just showing you one of the calculation here or this serial number 2 so here load that is if you one part in KN that means load in kg this into 9.81 x 10^{-3} so load will be = what is load? Load is 3.9 so 3.9 x 9.81 x 10^{-3} so if you calculate this is in KN will be 0.038.

So this 0.038 is KN so you are having 0.038 KN that means load is 0.038 KN. Now we measure the strain value okay, strain that is in percentage this is equal to deformation of the sample deformation of sample x 100. Deformation of the sample divided by length of the sample okay into length x 100 yeah. So strain = deformation of the sample/ length of the sample x 100 so if you now calculate then deformation of the sample you know that is 0.3.

So this is 0.3 this divided by what will be the length of the sample, length of the sample 'I' to live earlier that is length of the sample is here that is 76mm. So this divided by 76 this x 100 this is equal to 0.39 so this is 0.39 is the strain value 0.39 is the strain value. So here strain value 10^{-1} so this 0.39 will be the 3.9 so you calculate the, what should be the strain, now we have to determine that what will be the axial stress.

Because this corrected this area already we are initial value we have calculated 1138.55. So we have to calculate what should be the corrected area and what should be the axial stress so this corrected area we can calculate this is corrected area.

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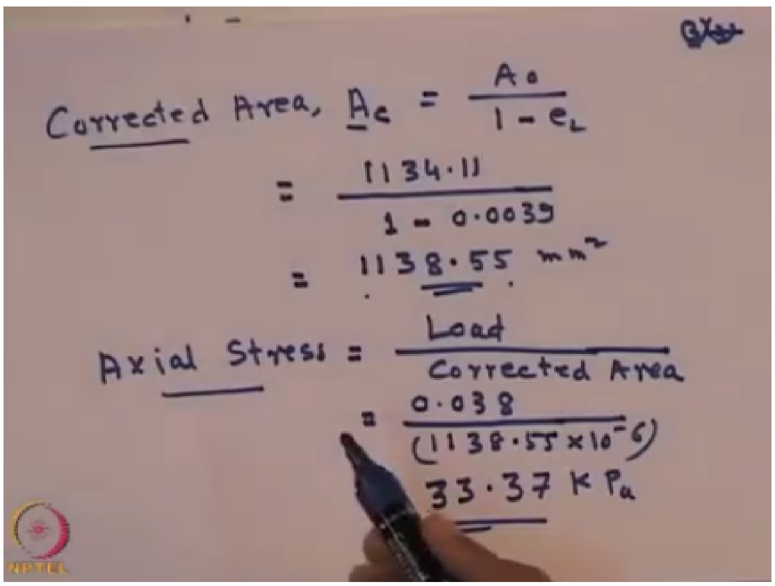

corrected area is designated at AC, AC = A0/1-e_L so what is $A_{0,}$ A_0 we have calculated earlier that means A_0 is 1134.11 okay this is A_0 so A_0 is 1134.11/1 – e_L that means e_L will be equal to your this value, okay.

That means it will be the 0.0039, 1 – 0.0039 okay that is the strain 1 – epsilon strain okay so if we calculate this then corrected area will be equal to 1138.55 mm^2 so we are we are here that what should be the corrected area so this is the corrected area 1138.55 this corrected area. So now we will calculate the axial stress so axial stress = Load/ corrected area, so load = this load is 0.038 KN so this is 0.038 this divided by corrected area we calculate it here 1138.55 x 10^{-6}.

So because you are expressing in terms of kilo Pascal so this axial stress will be equal to 33.37 K Particle so you are having the axial stress value in from here they will be 33.37 like that for all other deformation also you can calculate that what should be the axial stress so you can calculate that axial stress you can calculate that what will be the axial st7ress what will be the what we are collected area and what is the deformation. Now based on this table result you can draw a correlation between the axial strain and the axial stress, I am just showing here.

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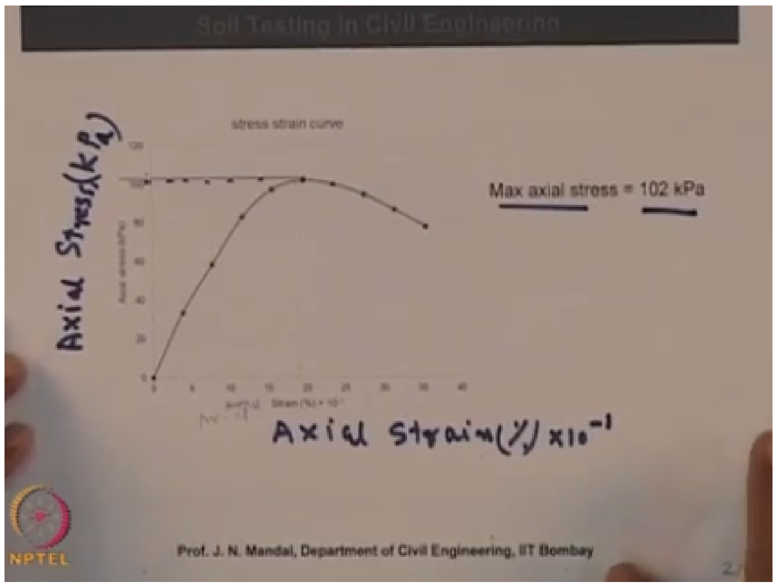

This is the axial strain this is axial strain in percentage this is 10^{-1} and this is the axial stress this is axial stress that is (KP_a) so for the different value of the axial strain and the corresponding axial stress which we can obtain from this table and then you can draw a curve we can draw a one stress table curve so and we can also achieve that what will be the maximum value of the axial stress.

So here maximum axial stress is 102 KP_a so from this stress okay you can draw that what will be the stress strain relationship of the soil, so from the stress strain relationship of the soil you can determine what will be the maximum axial stress in this case we are having the maximum axial stress about 102 (KP_a). While you can also draw the Mohr circle and the failure envelope for unconfined complicit strain.

So you know that the sample will and that sample will is about the axial stress value which I showed you here that is about 102(KP_a) so you can draw in the Mohr cycle diagram first. So if you draw in the Mohr cycle here.

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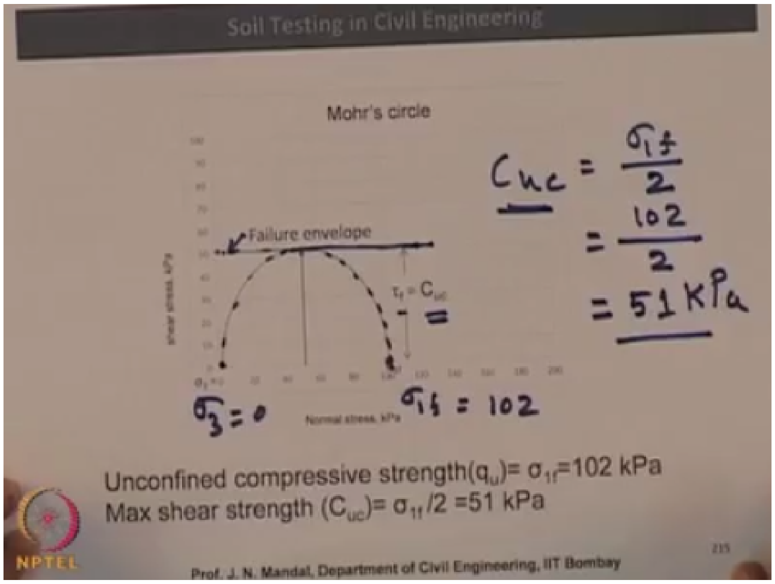

So this is σ3 = z0 this is σ3 = 0 and this is σ1f which you can say that failure at 102(KP_a) so this is σ_f this point is σ_f this point is σ3 so you can draw a semi circle and this is the failure envelope this is failure envelope this line is the failure envelope, so this is the normal stress verses shear stress, so you can determine what should be the shear stress that is $\tau_f = C_{UC}$, C_{UC} = maximum shear stress.

So unconfined composite strain value that is you or you can say that σ_f that is 102(KP_a) so maximum shear strain that is $C_{UC} = \sigma_f/2$ so that means 102(KP_a) /2 so this will give 51 KP_a so you can determine what will be the maximum shear strain using also this more circle diagram, from here you can also calculate. So I will show you next is the triaxial shear test.

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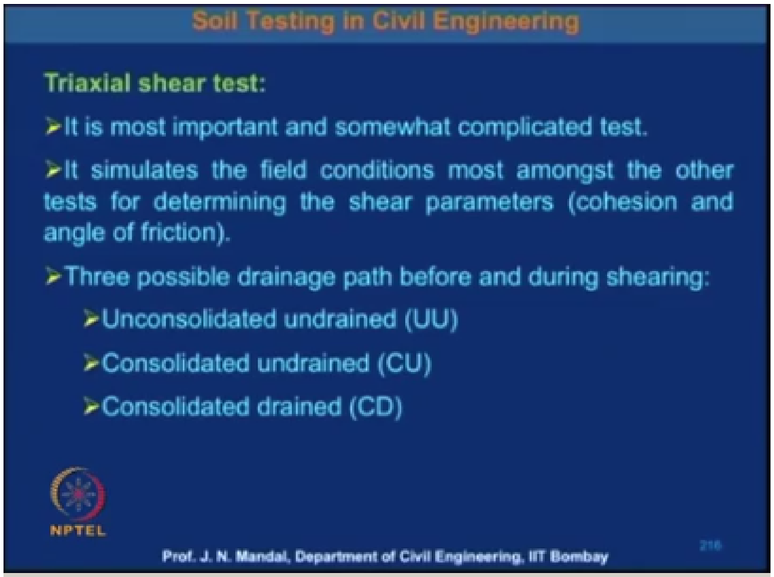

How we can determine the shear strain parameter using the triaxial shear test, so triaxial shear test is very important in soil mechanics. It is most important and somewhat complicated test so its stimulates the field condition most among the other test for determining the shear parameter that is cohesion and the angle of friction. So this triaxial stress have the three possible drainage path before and during the shearing.

So one it call unconsolidated un-drained test it call also consolidated un-drained test that designated as CU it also that other type of test which you call as consolidated drained test and that is call the CD test. So I have already earlier explained when its would be the unconsolidated unnecessary-drained test when it should be the consolidated un-drained test and when it should be the consolidated drained test depending upon that whether there is a drainage or there is no drainage whether it is consolidate or whether it is unconsolidated. Now here we have shown the triaxial set up.

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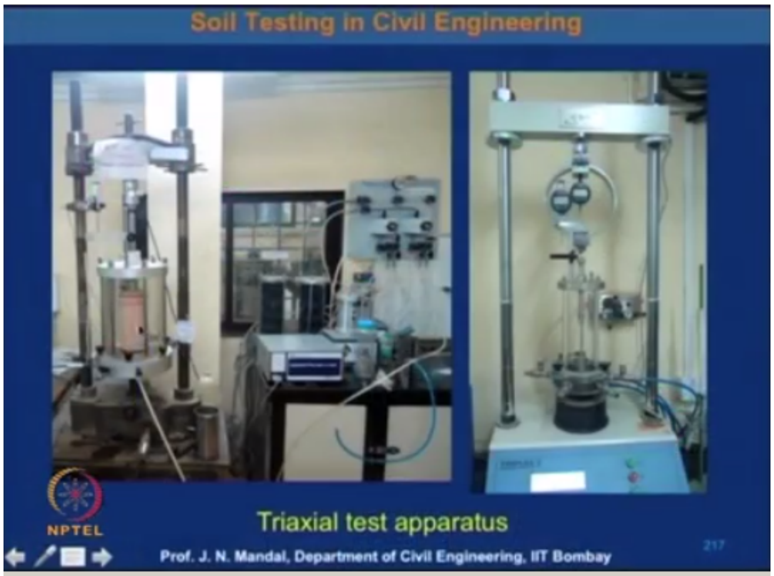

And can see this is the sample of triaxial sample that is 76 length and the diameter is ½ that is 36 here is the proving ring you can measure so this are the total set up of the triaxial set you can measure here also the poor order pressure through here so this is that triaxial test apparatus for the determination of the shear strength of the soil and particularly that what is cohesion and the angle of shearing resistance.

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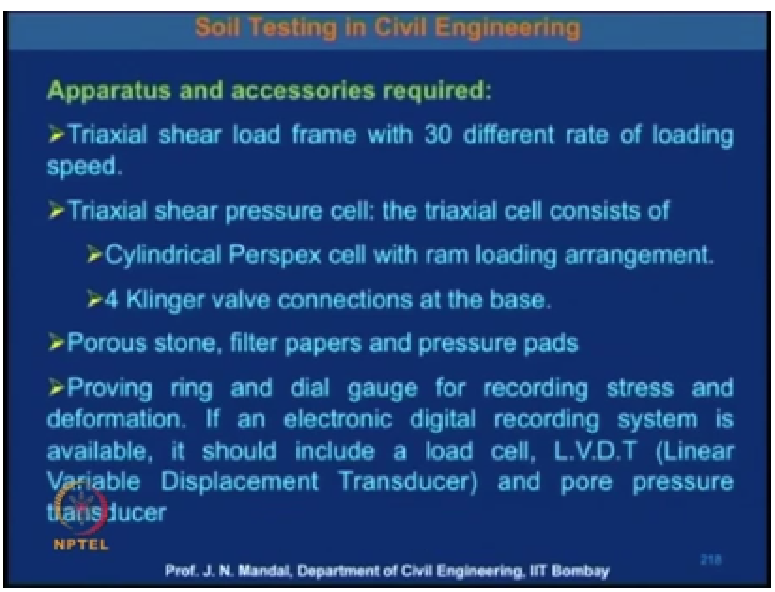

So this apparatus and that what will be the accessory require for the triaxial test, so apparatus are accessory require triaxial shear load frame with 30 different rate of loading speed, triaxial shear pressure cell: that is triaxial cell consists of it may be cylindrical Perspex cell with the ram loading arrangement, and 4 klinger valve connection at the base, proving ring and dial gauge for recording the stress and the deformation. If an electronic digital recording system is available, it should include a load cell that is called L.V.D.T that is linear variable displacement transducer and the pore pressure transducer.

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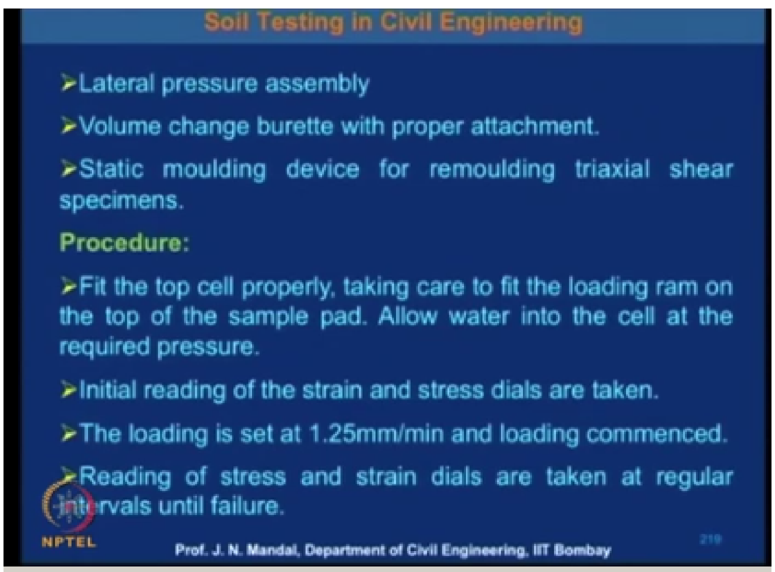

So next is the lateral pressure assembly, volume change burette with proper attachment, static moulding device or remoulding the triaxial shear specimen. Now these are the accessory at require to perform the test, now what are the procedure first fit the top cell properly, taking care to fit the loading ram on the top of the sample pad, then allow water into the cell at the required pressure. Initial reading of the strain and stress dial are taken.

The loading is set at 1.25mm/min and loading commenced, so you have to remember that loading rate is important, so here you are keeping the loading rate at 1.25mm/min, reading of stress and the strain dial are taken at a regular interval until the sample here.

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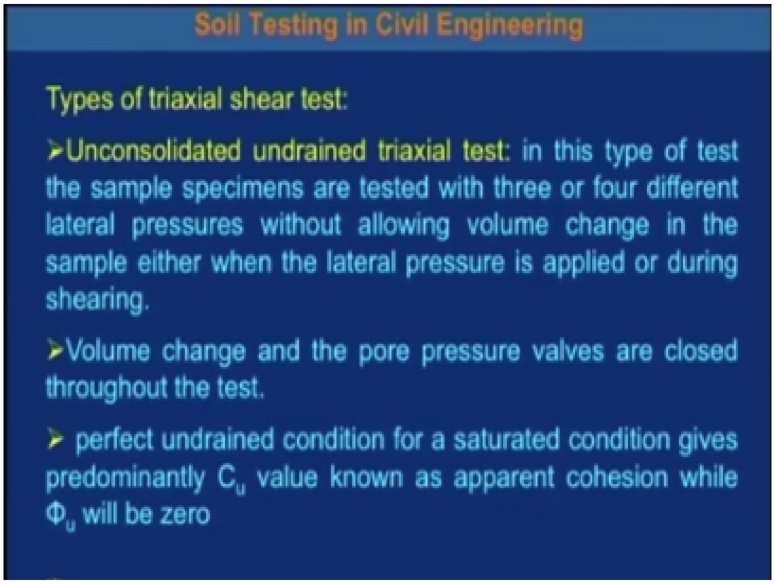

Now type of triaxial shear test, as I said it may be unconsolidated un-drained triaxial test. In this type of test the sample specimen are tested with three or four different lateral pressure without allowing the volume change in the sample either when the lateral pressure is applied or during shearing. Second volume change and the pore pressure valve are closed throughout the test. Next perfect un-drain condition for a saturation condition gives predominantly the C_U value that is known as apparent cohesion while the $Ø_U$ angle of shearing resistance will be the zero.

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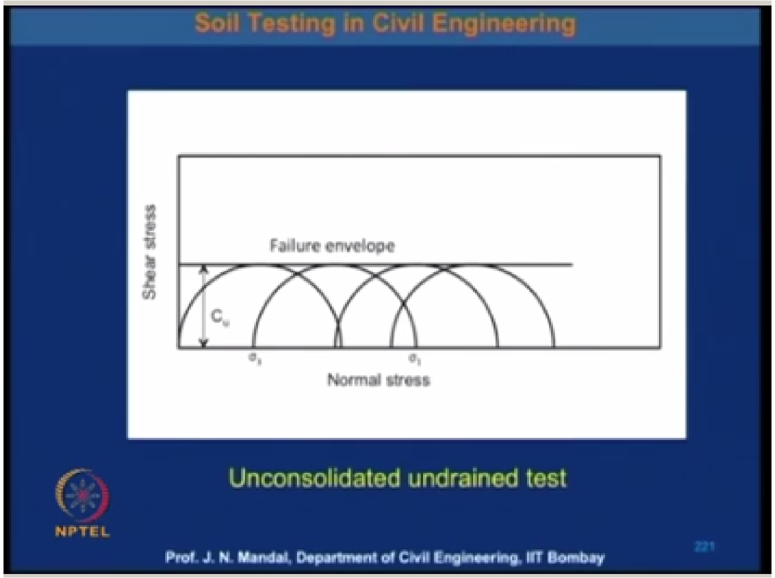

Now we can draw the part the un – consolidated un-drained test we can draw the this is the shear stress and this is the normal stress you can have this number of the Mohr cycle what $Ø_U = 0$ and this is the failure envelope we can have only that C_U value that means what is apparent cohesion intercept or the unconsolidated un-drained test so for the unconsolidated un-drained test you can determine what will be the apparent cohesion that is C_U, for $Ø = 0$.

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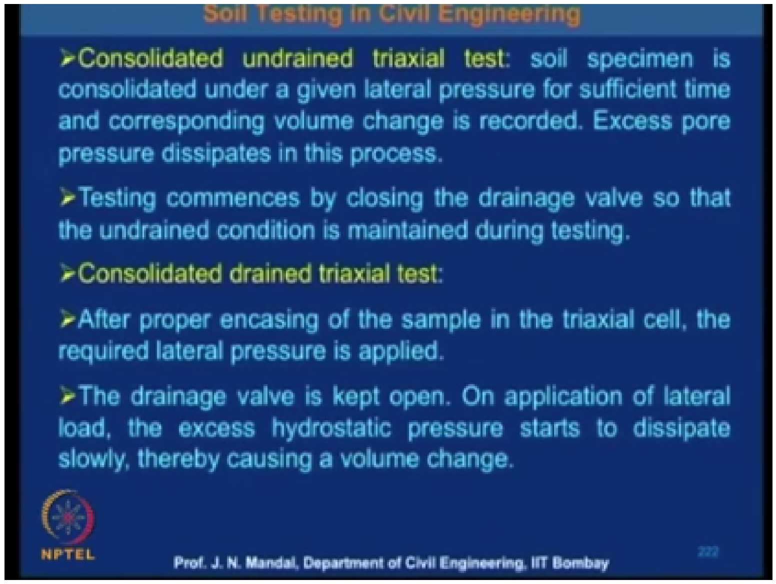

Now next is the consolidate un-drained triaxial test, so soil specimen is consolidated under a given lateral pressure for sufficient time and corresponding volume change is recorded and excess pore water pressure dissipate in this process, testing commencement by closing the drainage valve so that the un –drained condition is maintained during testing. So this the, this is the case in case of the consolidated un-drained triaxial test, thank you.

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