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Geotechnical Engineering Laboratory

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Lecture no – 15
Shear strength

Now I will show you the specimen calculation for direct shear test, let us say that mode of testing.

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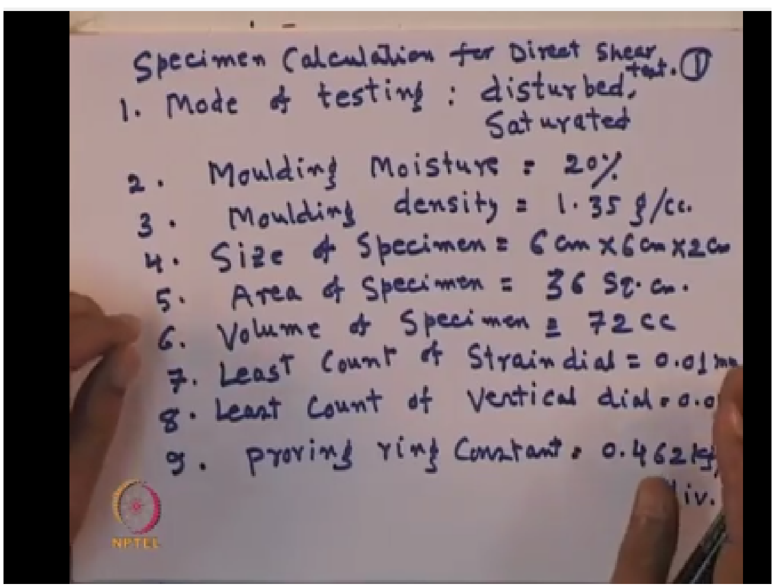

Is disturbed and it is saturated. So you should know what will be the moulding moisture = 20%. This is I am just showing some specimen calculation or direct shear test direct shear test. So you know that how to determine the moisture content and three is moulding density and let us say 1.35g/cc. You know how to determine moisture content and the density, now you know what will be the size of specimen in a small direct shear test that is you know that is 6cm x 6cm x 2cm. So then you can calculate that what will be the area of the specimen, so area of this mean is = 6 x 6, that means it is 36 square centimeters.

And volume of the specimen volume of the specimen is 72 cc, this is the volume of the specimen. Then you know that list count or strain dial that is 0.01 millimeter and then list count of vertical dial, that also 0.01 millimeter and 9 is the proving ring constant and that is 0.462kg/division. So from this we can measure that what should be the screen? What will be the vertical dilating? That we can measure and when you perform the test you have to perform the test under different normal stress.

Generally 0.5 kg/cm^2 ,1 kg/cm^2,1.5 kg/cm^2 so you so you have to perform the test it is it this is the serial number and you have to measure what will be the horizontal dial that is in division then you can calculate the horizontal deformation that also in millimeter can measure the space dial division and then you can measure the shear stress and that is in kg per centimeter square then you take the vertical reading and the what will be the axial deformation axial deformation in millimeter. So you have to perform that test okay, so this one let us say this is serial number and what would be the horizontal dolt?

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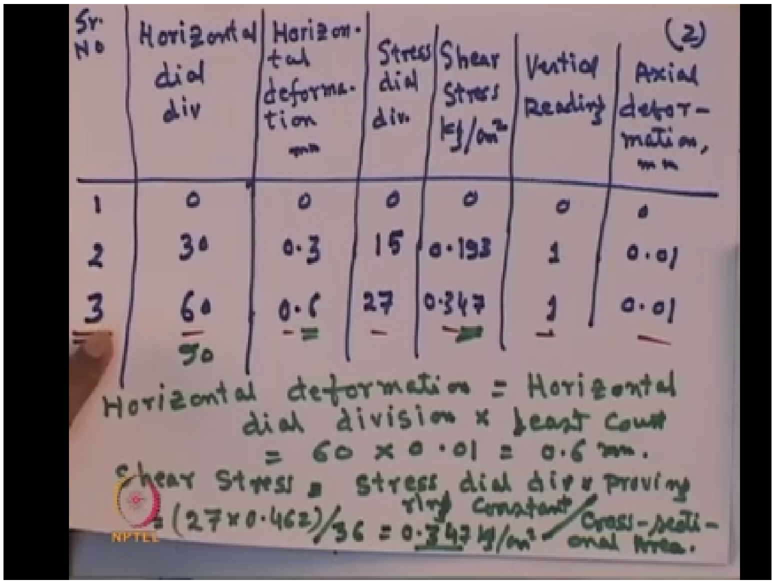

That is in division. Then you can calculate horizontal deformation that also in millimeter, can measure the stress dial division and then shear stress that is the kg/cm^2, then there is vertical reading and the axial deformation. So we have to perform all these, so let us say 1000000, so let us say 2 horizontal dial division 30, so horizontal deformation will be 0.3. Let us say stress dial division is 15 and the shears stress value 0.193 and this vertical reading let us say 1 and the axial deformation is 0.01.

Let us say that serial number 3 when the horizontal dial division is 60 and horizontal deformation is 0.6, stress dial division is 27 and shear stress 0.347 and vertical reading is 1 so this is 0.01. I will show you one of the calculation, that how here we have determine, so I will show also for serial number three all this parameter how we have calculated? So you know that horizontal deformation this one, so horizontal deformation = horizontal dial division x this count. So horizontal dial division is 60 and this count is 0.01, which I have sonic earlier this count is 0.01 okay this is horizontal discounted 0.01.

So that means horizontal dial division it this = 60 x lists count I showed you 0.01, so this will give 0.6mm, so that is why it is 0.6mm for enter deformation. Now how to calculate the shear stress? So shear stress, let us say shear stress is equal to that is stress dial division x moving ring, moving ring constant this /cross-sectional area. So this will be = stress dial division e 27 so this is 27 x that is moving constant and this moving ring cost and I told you that is 0.46 to kg per division. So 27 x 0.462, 27 into 0.462 this divided by the cross sectional area and here is cross sectional area radii 36.

So this is 36 so this will be can calculate you can add 0.347 kg/cm^2 . So this is 0.347 kg/cm^2. Similarly particle readings are both 1 and then axial deformation this is axial deformation for vertical dial 0.01, so that is why it is 0.01. So like this to perform the test and you have to take the reading for the horizontal dial division, it may be 0, 30, 60 this it may be the 90 it may be 120, 150, 180 like that here to continue and I am just showing you that these are different reading you are taking like that here to continue and take.

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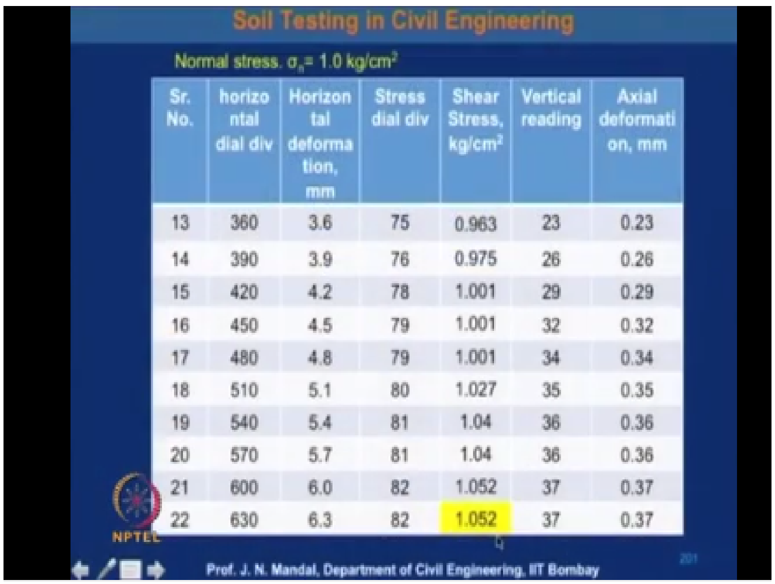

Sr. No.	horizontal dial div	Horizontal deformation, mm	Stress dial div	Shear Stress, kg/cm^2	Vertical reading	Axial deformation, mm
13	360	3.6	75	0.963	23	0.23
14	390	3.9	76	0.975	26	0.26
15	420	4.2	78	1.001	29	0.29
16	450	4.5	79	1.001	32	0.32
17	480	4.8	79	1.001	34	0.34
18	510	5.1	80	1.027	35	0.35
19	540	5.4	81	1.04	36	0.36
20	570	5.7	81	1.04	36	0.36
21	600	6.0	82	1.052	37	0.37
22	630	6.3	82	1.052	37	0.37

The CSS value what you are having the maximum value you can see here, you can say that under normal division you are taking you are taking the

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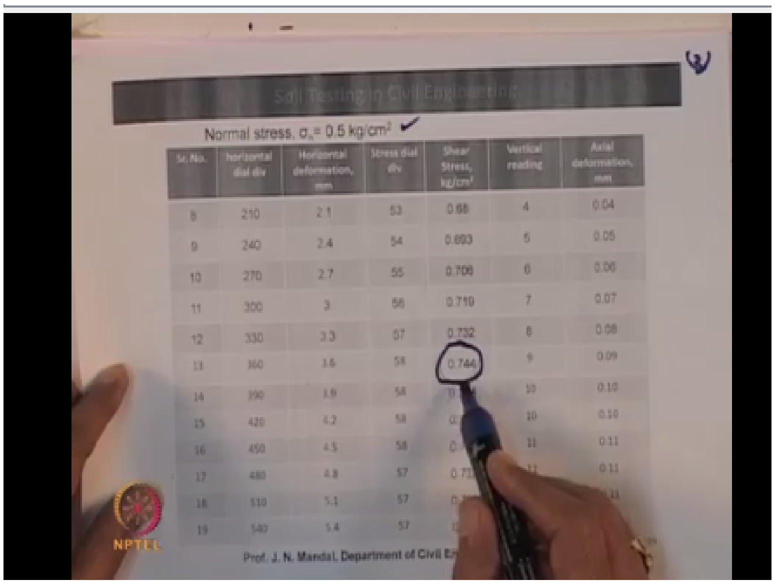

You are taking you are taking the shear stress value almost maximum is here that will 0.744 kg/cm^2 , so this is the value we are having but shear stress value under the normal stress of 0.5 kg/cm^2 . So if you have to perform the test under different normal pressure, so when the normal pressure is 0.5 kg/cm^2 you are having the maximum shear stress value 0.744. Let us see that from this table, we can write that when the normal stress.

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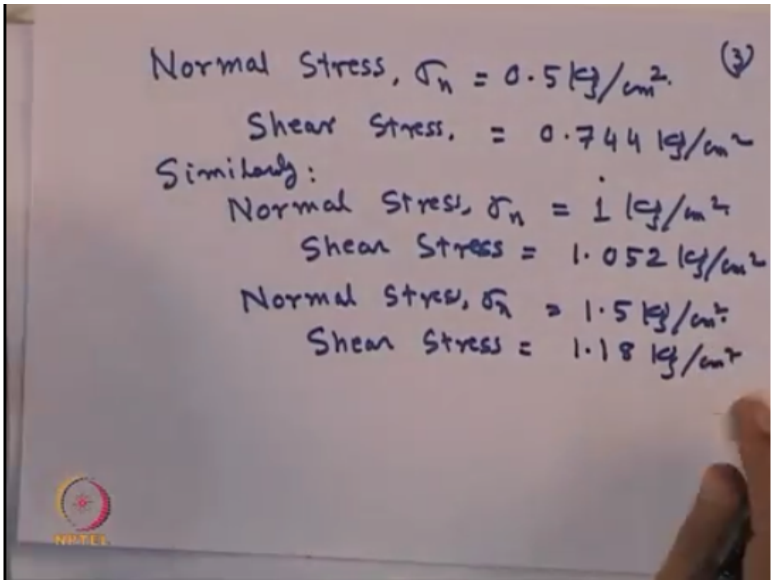

That is σ n is equal to 0.5 kg/cm^2 then you are having the maximum shear stress = 0.744 kg/cm^2. So under this normal stress you are having the shear stress value, similarly yet we again apply the normal stress, let us say has a normal stress σ n = 1 kg/cm^2 and then you can determine what should be done shear stress maximum shear stress value? So you can have the maximum shear stress value, you can see here that when the normal stress is 1 kg/cm^2 and then you are taking the reading and you are determining the shear state, as you have done in case of normal shear stress value 0.5 kg/cm^2 and for 1 kg/cm^2.

You are having this maximum shear stress value 1.052. So similarly when the normal stress is 1 kg/cm^2 you are having that shear stress value is 1.052kg/cm^2 now in the normal stress σn =1.5kg/cm^2 and then you have to determine what will be the shear stress shear stress so you can have that when the normal stress is here 1.5 kg per centimeter then after taking the reading the CST value you can calculate it and then you find what should be the maximum shear stress that is 1.18 so this S value is 1.18 this is kg per centimeter square .

So what you are having from this directive under the different normal stress you are calculating that what will be the shear stress when the normal stress is 150 kg per centimeter square then see our state 7.744 kg per centimeter square when the normal stress is one kg per centimeter square and see our state value is 1.052 kg per centimeter square and when the normal stress is 1.5 kg per centimeter Square.

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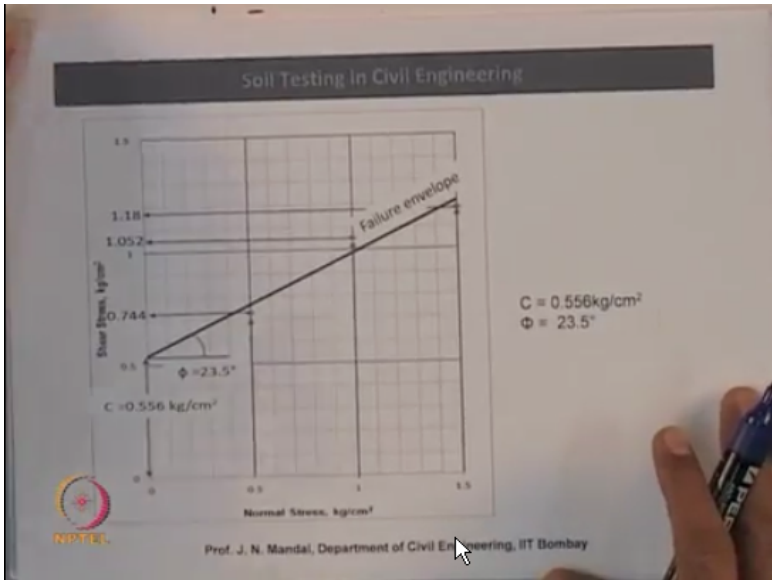

And then there is 1.18 now we can plot the good graph in between the normal stress and the shear stress for the determination of the parameter so and the showing that what should be the normal stress and what should be the shear stress value so here you can see the figure this is a normal stress and this is the shear stress so we know that when the normal stress is normal stress is 0.5 when the normal stress is 0.5 then shear stress is 0.74 for that means when the normal stress is 0.5 here.

And then this shear stress value it this one when normal stress is 0.5 so you can plot this point okay when the normal stress is 1 kg/cm^2 shear stress is 1.052 that means when normal stress is 1 then shear stress value you are having 1.052 this one that means you can have a point somewhere here when the normal stress is 1.5 shear stress is 1.18 so when normal stress is 1.5 then shear stress value is 1.18 so you are having a point here so you are having one two three point then you draw a line which you called the mode failure envelop line and this angle.

This angle is equal to ρ and this intercept this is what you called as cohesion so you can measure the cohesion which is C=0.556 kg/cm^2 you are having angle of shearing resistance ρ=23.5 so on this direct shear test so you can determine what is the normal stress what will be the CF state value so if you know the shear stress and normal stress so you can draw the failure envelope.

And from this failure in block you can determine what will be the angle of shearing resistance that is ρ and here ρ=23.5degree centigrade and the cohesion intercept that you see that is t=0.556

kg/cm[2] this is what it called the shear strength parameter and this parameter is very important for design for any infrastructure in geotechnical engineering.

So we should know how to perform the test direct shear test and how to calculate the shear stress under the different normal stress and then you can determine what will be the CF CS then parameter that is C and we can also determine the vertical deformation and, and the load and that also you can put to determine the displacement of the soil.

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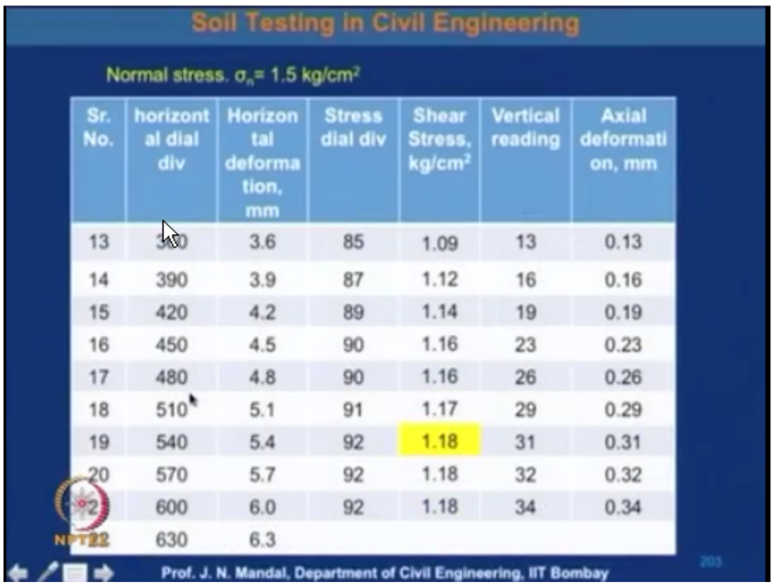

Sr. No.	horizontal dial div	Horizontal deformation, mm	Stress dial div	Shear Stress, kg/cm²	Vertical reading	Axial deformation, mm
13	[illegible]	3.6	85	1.09	13	0.13
14	390	3.9	87	1.12	16	0.16
15	420	4.2	89	1.14	19	0.19
16	450	4.5	90	1.16	23	0.23
17	480	4.8	90	1.16	26	0.26
18	510	5.1	91	1.17	29	0.29
19	540	5.4	92	1.18	31	0.31
20	570	5.7	92	1.18	32	0.32
[illegible]	600	6.0	92	1.18	34	0.34
22	630	6.3				

Now you can also plot the horizontal deformation and the this shear stress so you know that horizontal deformation from this table from this table you know that what will be the horizontal deformation under different load it may be 0.5kg/cm[2] 1kg/cm[2] and the 1.5kg/cm[2] so under the different normal stress you can determine the horizontal, horizontal but horizontal that deformation.

Let us say here this is the horizontal deformation okay this is let us say this is horizontal deformation under the load of 1.5 kg/cm[2] this also like this, this also you can also see also the earlier that what should be this is after 1.5 kg/cm[2] what will be the horizontal deformation similarly for the 1.0 kg/cm[2] 1.05 and also 0.5 kg/cm[2] like that from the different loading so you can determine the deformation so this is a horizontal deformation in the x-axis and the CSS on the y-axis.

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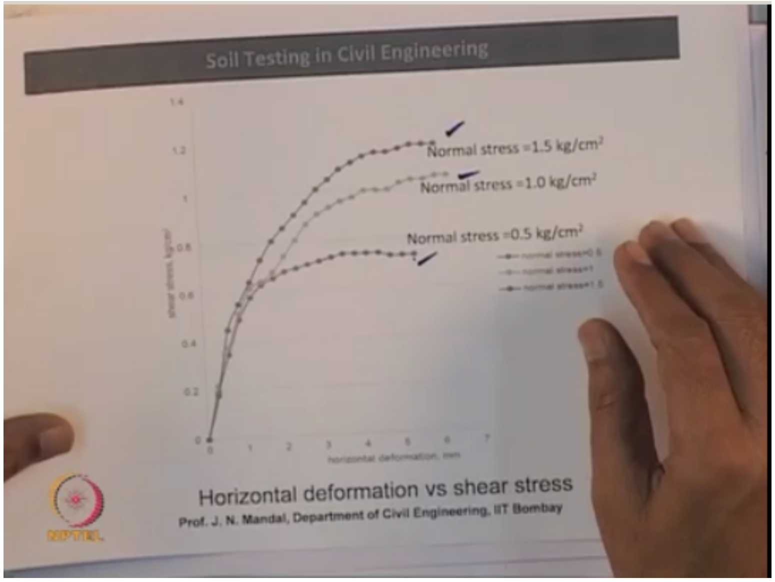

So under the different normal stress so you can plot the curve in between the shear stress and the horizontal deformation so this is the under normal stress of 0.5 kg/cm^2 this is for 1 kg/cm^2 and this is for 1.5kg/cm^2 so here including the normal stress and shear strain value also a column is increasing now there are different types of the test and if it is a if it is a unconfined compression test.

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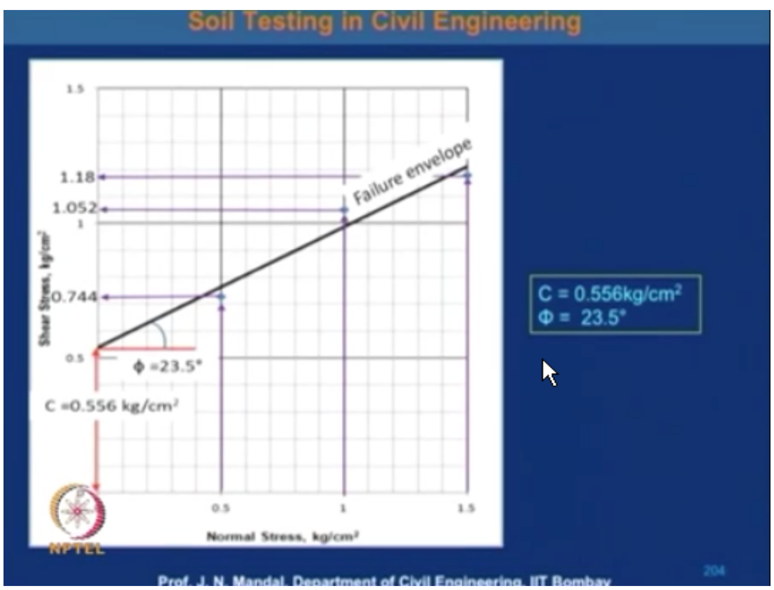

So in case of unconfined compression strength that is q_u is the load per unit area at which the cylindrical soil specimen fails in compression it is the twice the cohesive strength or untrained shear strength for saturated clay let us say this unconfined compression test.

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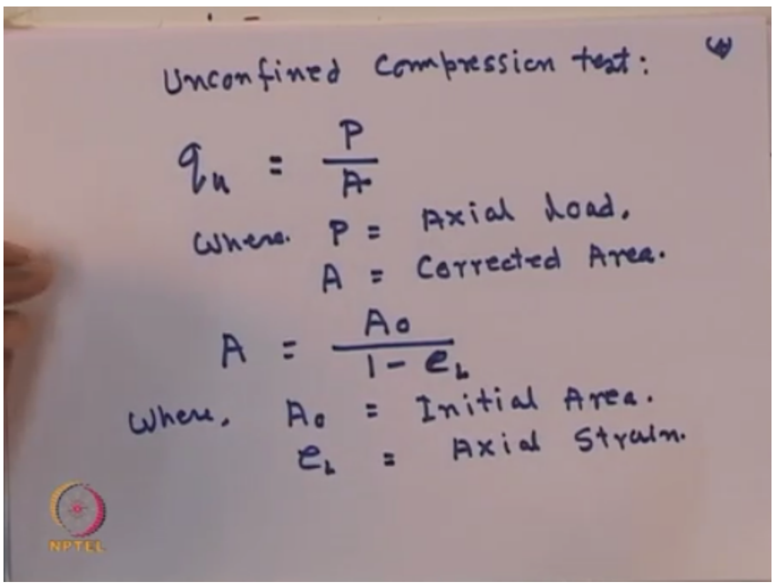

Let us say this is uncontained compression test so there is no unconfined okay so unconfined compressive strength which can be designated as q_u so this unconfined compression strength $q_{u=}$ P/A where P is axial load A is corrected, corrected area and this corrected area will be equal to $A_0/1\text{-}e_l$ where A_0 is initial area, initial area and e_l is axial strain so you need that collection of the area.

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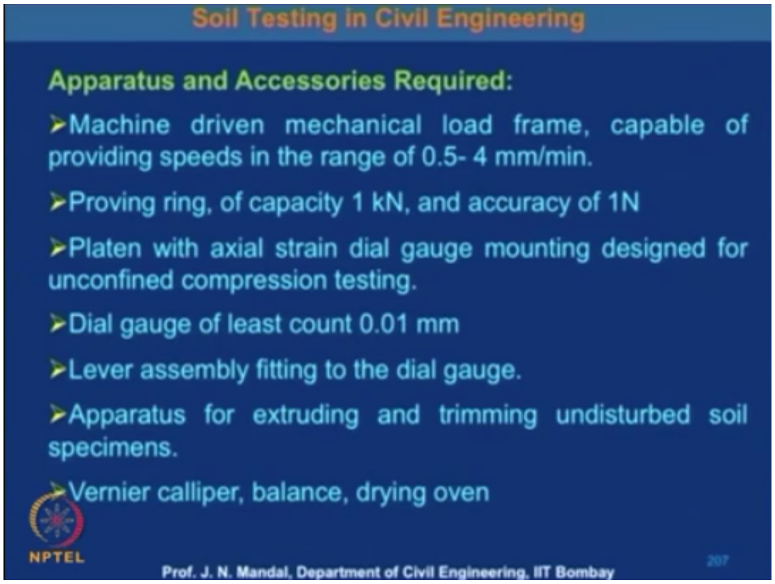

So you will be knowing what will be the initial area of the sample and also you know that what should be the axial strain then you can determine what should be the corrected area that is $A_0/1\text{-}e_1$ so what this kind of the test also you recall some apparatus and the accessory require so machine driven mechanical load frame capable of providing the speed in the range of 0.5-4mm/min because rate of speed is very important in case of this kind of the testing unique providing ring of capacity 1 kilo Newton and accuracy of 1N.

A platen with the axial strain dial gauge mounting designed for unconfined compression testing the dial gauge of least count of 0.01millimeter lever assembly filling to the dial gauge apparatus for extruding and trimming the undisturbed soil specimens and venire caliper balance and drying oven and showing you what are the that equipment is needed here.

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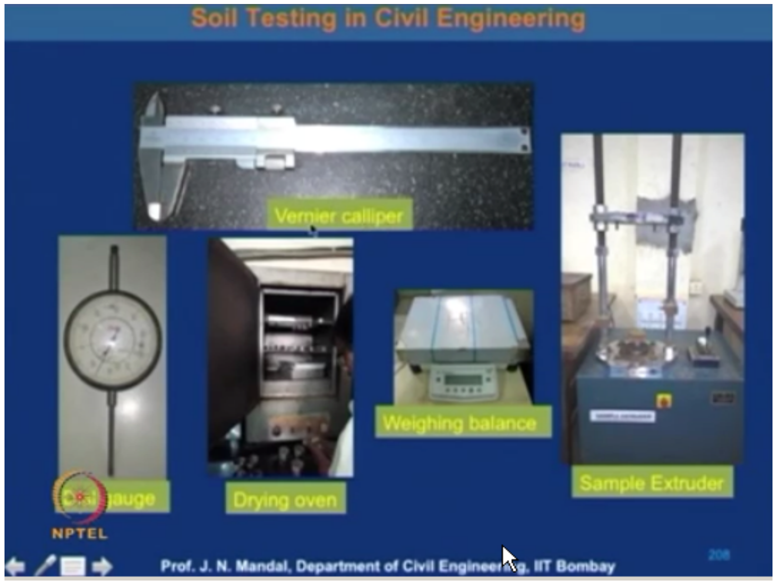

This one is the venire capillary this one and this is the dial gauge here target which you can measure then this is the drying oven in which keep the sample or dry and this is the waiting balance you can wait the soil specimen and this is the sample exclusion any sample is to be excluded from the mould for the testing and here also unconfined compression test.

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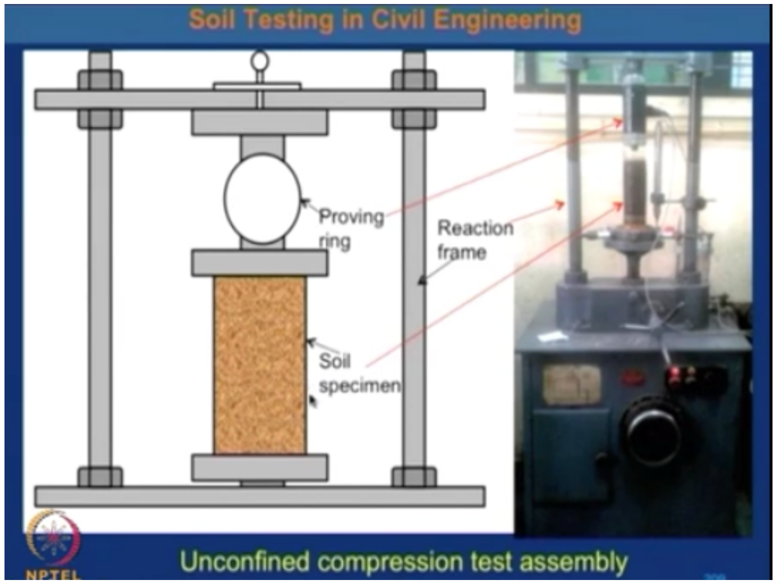

This is the test assembly and here is the soil you can see soil specimen here is a proving ring and this is the reaction frame so this is the soil sample this unconfined compression test and you can see this is the this soil sample is here and you can apply the load at a particular speed and then you measure what will be the unconfined compression strain of the soil.

So because it is a unconfined compression test so there will be no unconfined effect so only a determine what is unconfined compression strength of the surge this also parameter is very important so this is also one of the simplest test NEC it will be knowing that what should be the unconfined compression test of the soil sample. Thank you.

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