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Geotechnical Engineering Laboratory

Prof. Jnanendra Nath Mandal
Department of civil engineering, IIT Bombay

Lecture No – 14

Shear Strength

Welcome I am J. N. Mandal department of civil engineering Indian institute of technology Bombay so for we are discussing about this shear strength of the soil now if we saturated soil sample is loaded a portion of applied stress goes to brain and other position will be registered by the pressure which will be developed in water called pore water pressure.

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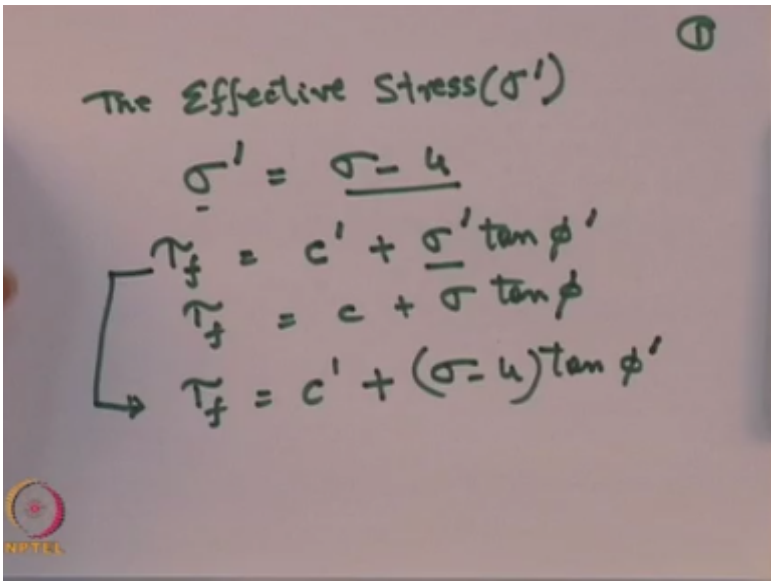

So the effective stress can be expressed as the effective stress is designated as σ` so effective stress can be expressed as σ` = σ – u why σ = total stress and u is more what are stress now colin's equation the expression for the educational in terms of the effective stress that education is colin's equation is τ here is equal to c` + σ` x tan ϕ` where this c` and σ` is the effective stress parameter and in terms of the total stress also you can write $\tau_f$ = c + σ into tan of ϕ where c is coefficient and ϕ is your angle of shearing registers and this in terms of total stress and c' and σ` in terms of the effective stress now in this equation we can write the τ_f = c' + σ` = σ` - u.

So this is σ – u this into tan of ϕ' so these are the effectives c' and ϕ' is the effective stress parameter now shear strength is not an entrance property of a sign but is varies over a considerable range with a varying condition such as it depend on the density it is depend on the moister content as well as this depend on the degree of consideration the general methods available for determine the shear strength of the soil so some of the method are available for the determination of the shear strength of the soil.

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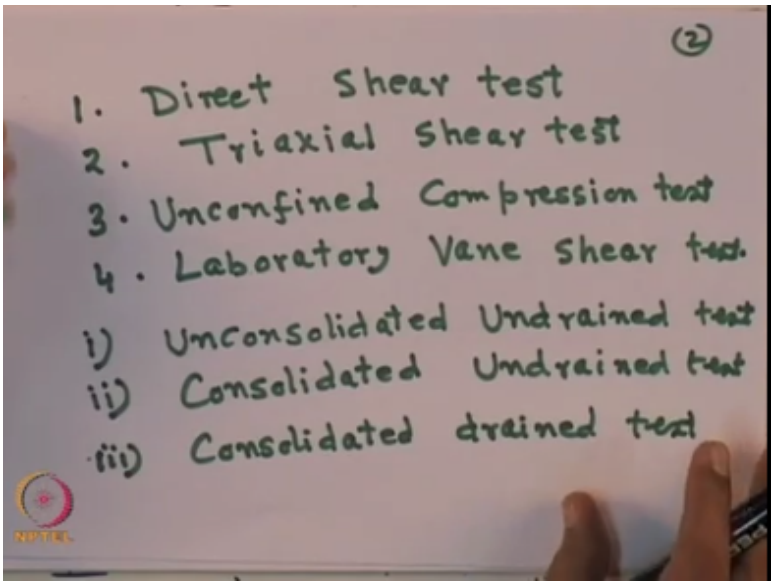

One is the direct shear test so we will discuss later about that what is direct shear test second is the triaxial shear test and 3rd is unconfined compression test and 4th is laboratory vane shear test. So this direct shear and triaxial shear test on soil usually fall in three groups so this 3 groups are one which you call the unconsolidated undrained test, you can say also u test and second is that consolidated undrained test and third is consolidated drained test so these are the different types of the test, it may be consolidated undrained test u test consolidated undrained test cu test or consolidated drained test.

Now the type of the triaxial that compression test and is drainage condition this is very important that what should be the drainage condition so what we do generally.

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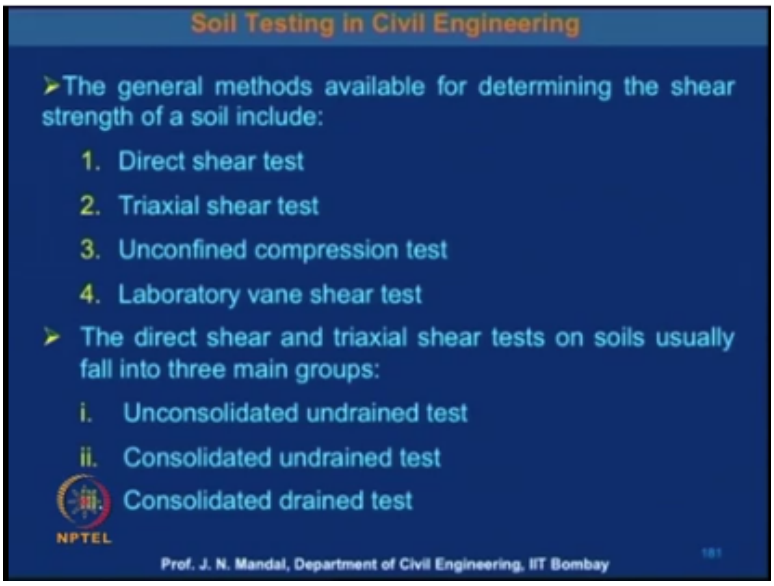

That we do first all that how we have to prepare the soil sample.

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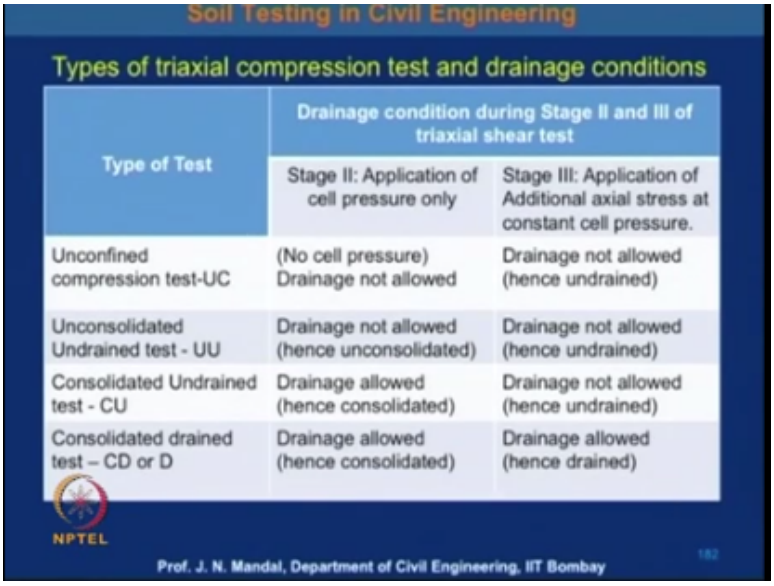

So you prepare the soil sample and then you apply the load so it depends up on the what should be the drainage condition dealing the stage 2 and 3 of that triaxial shear test, so first of all that if the type of the test here is the unconfined compression test which we can say that UC test so after the preparation of the sample what we have to do we have to apply the cell pressure that means stage 2, first stage is the preparation of the sample second stage is the application of cell pressures already so if you apply the cell pressure so because it is unconfined.

So there should be no cell pressure so drainage not allowed so this is very important for axial stage when we have to allow the drain and in the 3rd stage that means when application of additional axial stage at a constant cell pressure. Then means drainage not allowed that is why it is undrained, so you know that if it is a unconfined compression test that means UC test so when application of cell pressure only mean no cell pressure drainage not allowed and when it is 3rd stage that application of additional axial stage at constant cell pressure that mean drainage not allowed hence it is undrained.

Now if the type of the test is unconsolidated undrained test that if it is a UU test then stage 2 application of cell pressure only that means drainage not allowed hence it is unconsolidated and 3rd stage when the application of additional axial stage at constant cell pressure that means here also drainage not allowed hence it is undrained and that is why it called consolidated undrained test.

And 3rd case if it is a consolidated undrained test which you call CU test in stage 2 after the preparation of the soil in stage 1 if in stage 2 is a application of cell pressure only that means in case of consolidated undrained is drainage allowed hence it is consolidated and the 3rd stage when the application of additional axial stage of constant cell pressure that means drainage not allowed hence it is undrained and 4th life of test is consolidated drained test or the D test or drained test.

In the second stage the application cell pressure then drainage allowed hence it is consolidated and 3rd stage the application of additional axial stress at constant cell pressure that means drainage allowed hence drained so once it know that when we have to allow the drain and when we are not to allow the drain so this is drainage condition dealing and stage and 3 of the triaxial shear stage is very important.

Then you will be, knowing what type of the test you are performing weather it is unconsolidated undrained test whether it is unconsolidated compression test or it is unconsolidated drained test or it is unconsolidated undrained test or unconsolidated undrained test. So you will be, knowing that what type of the test you are performing now we will discuss that more theory of lecture more represented that healed or the value within a material is not caused by normal stress alone reaching a maximum value.

But by a critical combination of both shears stress as well as normal stress the critical combination of shear and normal stress when plotted on a σ_1 and τ_1 from a line that is known as more envelopes or lecture value really occur if for a given value of σ_1 the shear space exit that value.

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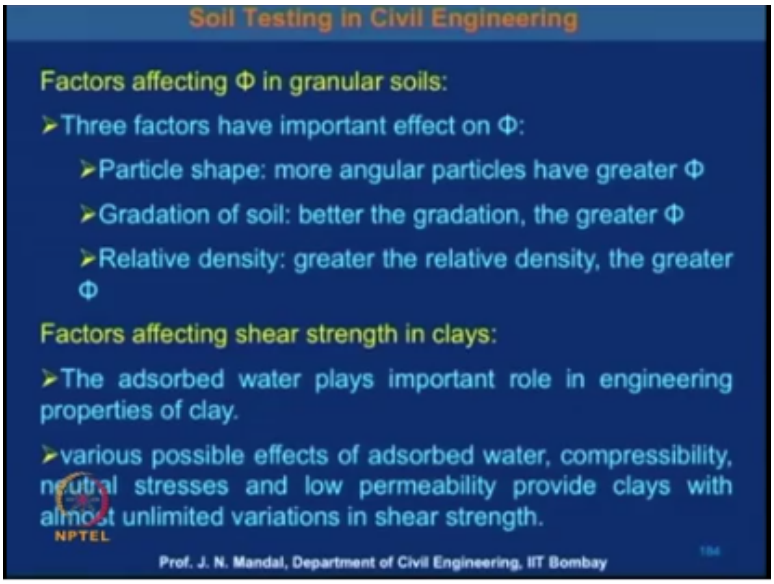

So we can draw the more envelope line now what are the factor affective the Π in a granular soil, generally there are 3 factors and important effect on Π manage what is the particle shape the more angular particle have the greater Π value 2nd gradation of the soil greater the gradation the grater of Π and 3rd is the relative density greater are relative density mean greater Π now also this shear strength parameter effect the factors affecting the shear strength in clay.

Now they absorb water plays important role in engineering properties of clay various possible effect of absorb water compressibility neutral stress and low permeability provide clay with also most unlimited variation in the shear strength value.

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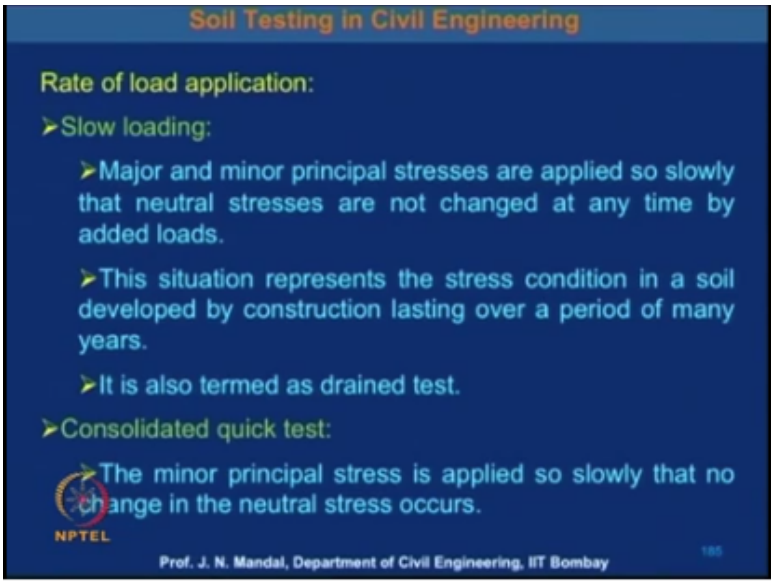

So these are the factor parameter which affect the moisture content so value of shear strength and shear strength parameter also vary, now what is the rate of load application, then will be slow or then will be quick test it is slow loading that you measure and minor principle stress are applied so slowly that neutral stress are not change at any time by added loads this solution represent the space condition in a cell developed by the construction lasting over a pair of many years it is also turned as drain test.

In case of the drain test because if drains is taken lot of time to consolidated so it is it takes time lot of time that is why it is a slow loading test and other is consolidated quick test the major principle stress is applied so slowly that no change in the neutral stress occurs, so the major principle stress is applied so rapidly that neutral stress carried all the additional stress this is known as consolidated undrained shear or which call be united at CU.

And quick loading what the measure and the minor principle stress are applied so rapidly that effective stress are unchanged and the neutral stress carries the additional load.

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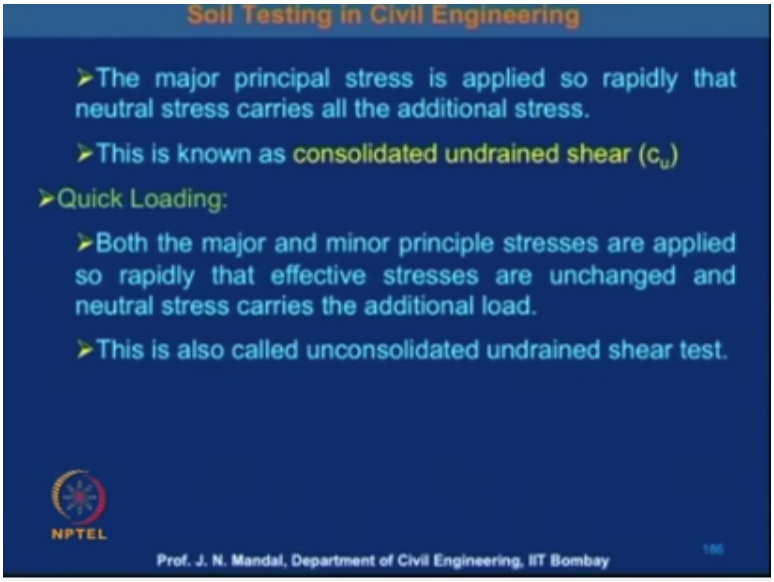

This is also called the consolidated undrained shear test.

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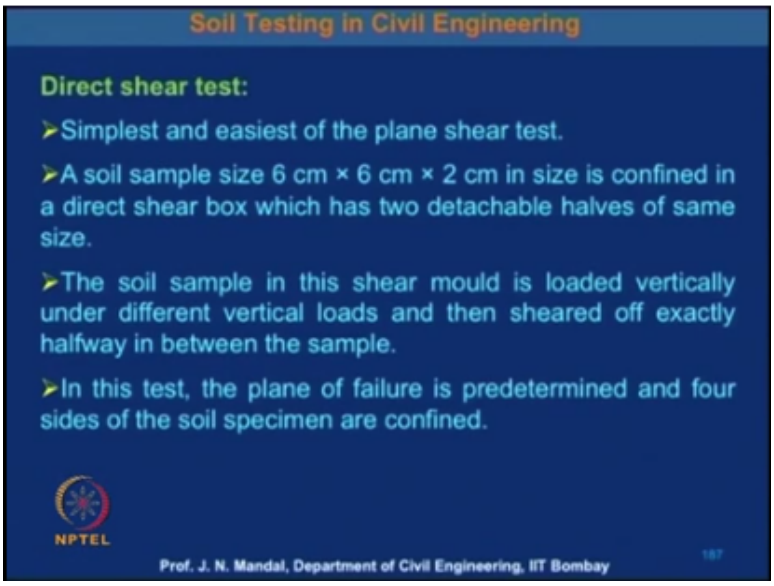

Direct shear test these are simplest and easiest of the plane shear test a soil sample of Size 6cm x 6 cm x 2 cm in size is confined in a direct shear box which have 2 detachable halves of same size. The soil sample in this shear mould is loaded vertically under different vertical loads and then shear of exactly half way in-between the sample in this stage the plane of value is predefined and 4 side of the soil specimen are confined.

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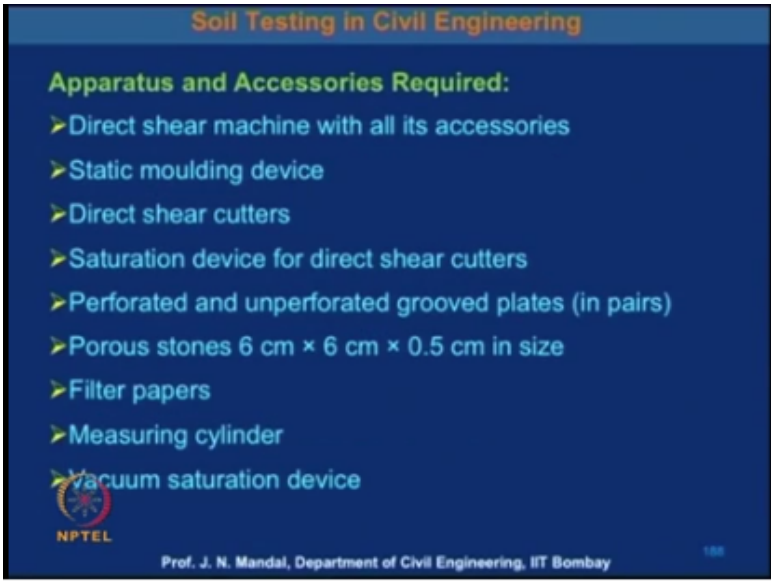

So what are the apparatus and the accessories required for the direct shear test I will now explain that what are the accessory requirement 1 is the direct shear machine with all it is accessory in is the static molding device shear cutter in saturation devices of direct shear cutter populated and unpopulated grouped plate in shears where as stone that is 6cm x 6 cm x 0.5 cm in size filter paper measuring cylinder and vacuum saturation device.

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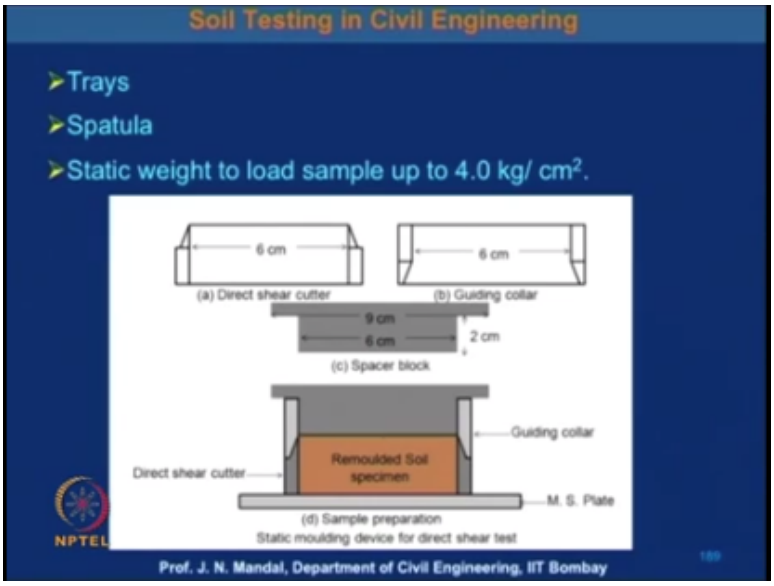

So and apart from that you required what is trays, spatula and static weight to load sample up you 4 kg / cm^2 and just showing 1.

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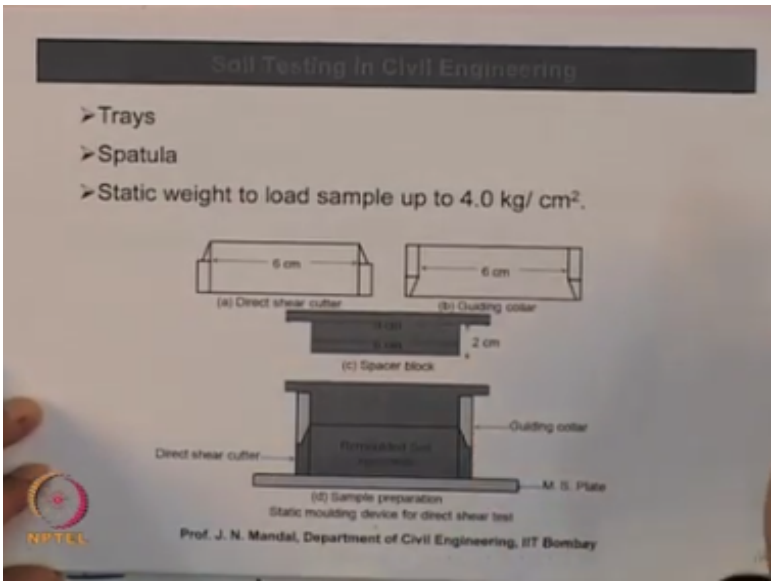

This is the static molding device what direct shear test and this is the MS plate this is remolded soil specimen and this is gelding color this is the direct shear cutter and here is the pressure block this is 6 cm and this is 2cm and this is 9 cm, and this gelding color that is about 6 cm and this is direct shear cutter and this about 6 cm so these are the static molding device for direct shear test.

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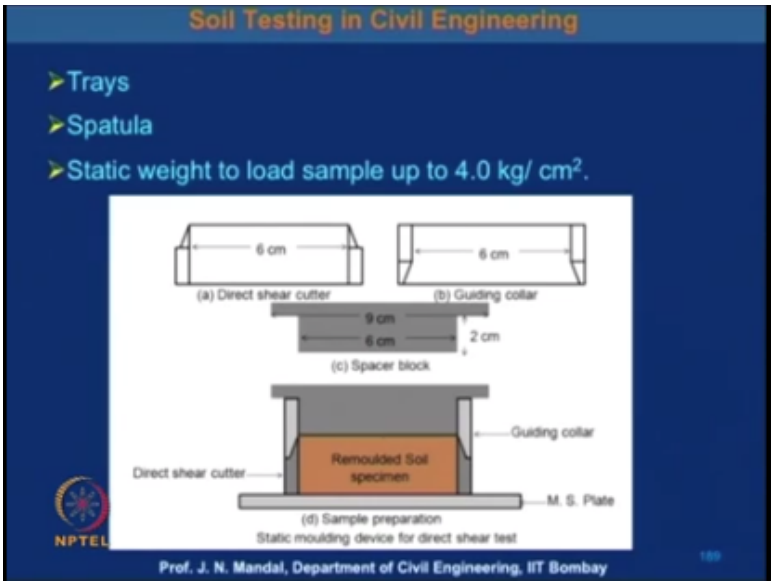

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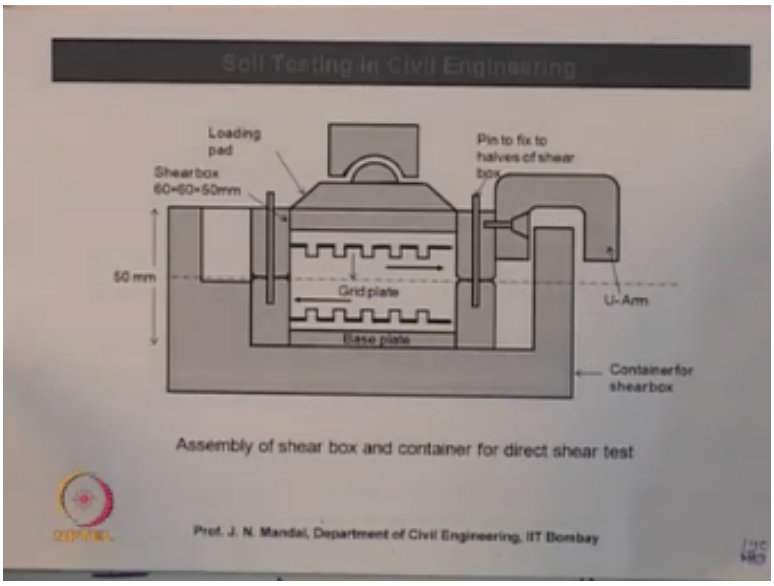

Now I can show you this is the assembly of the shear box and the container for direct shear test this is the lower plate this is base plate and these are the upper part and this is the loading pad and this is the shear box so size is about 16 to 60 and the 50 mm and here is a pin to fix the hope of the shear box and this is 50 cm this is 60/ 60 there is a base plate there is a grid plate and this is the u arm and this is the container for the shear box.

So soil will be assemble here and compacted and this is also lower parts soil upper part soil and there is a bridge shear in between the half of the shear box operators so it is shearing it is in the direction and it is in this direction so from this is the assembly of the shear box and container for the direct shear box test so how to assemble the sample and how you can perform the shear box test.

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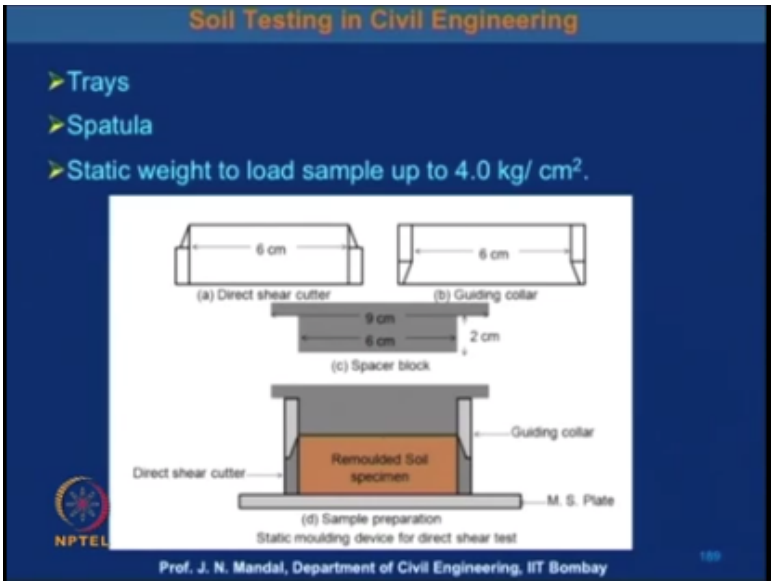

This is.

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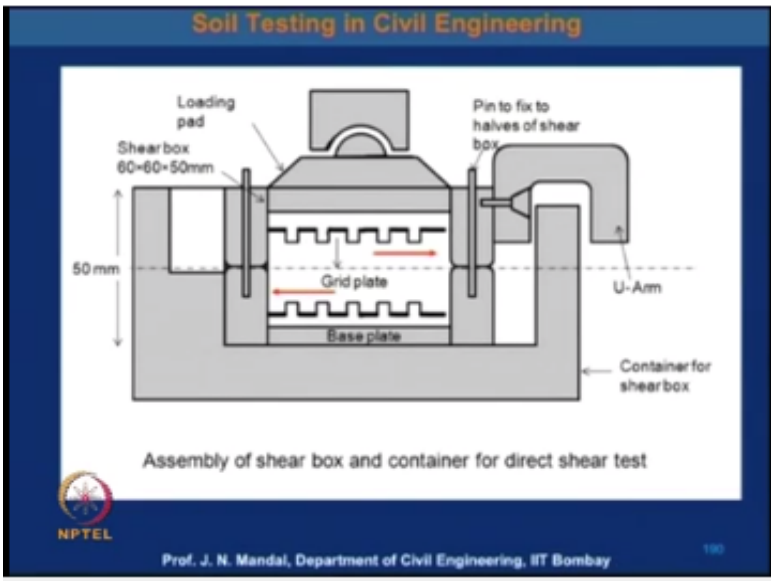

I am showing.

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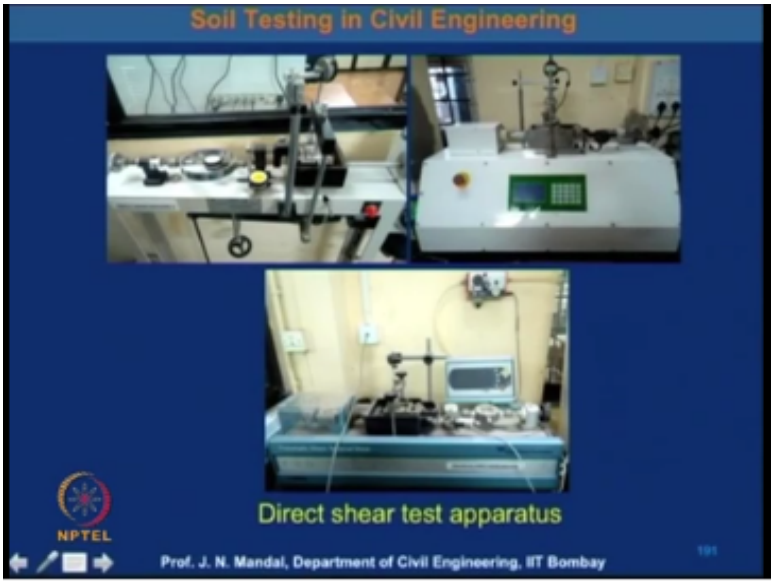

This is the shear direction box takes apparatuses what is separately explain you this is all direct shear box test okay any way the shear strength parameter of the soil is determine using this shear box test.

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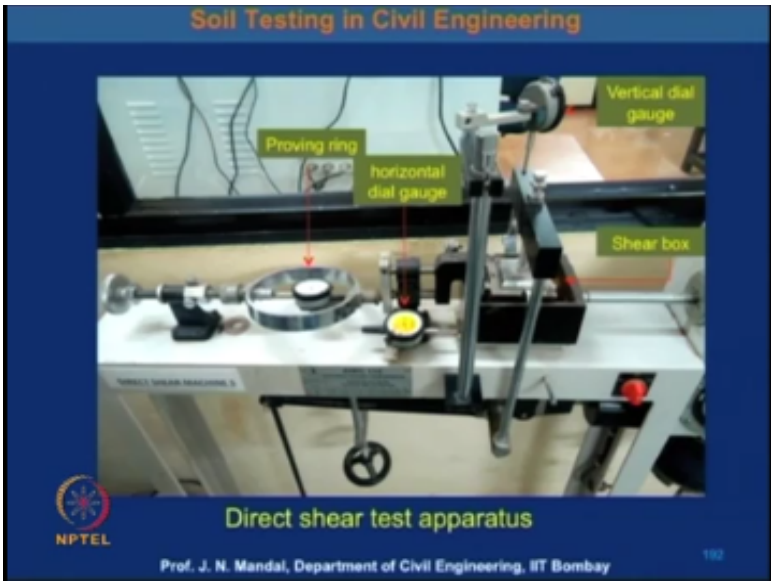

This also direct shear box test you can see here this is the proving ring you can measure with the help of the proving ring this is the horizontal dual gauge and this is the vertical dual gauge and this is the shear box okay this is the shear box so you can measure the proving and then the load is applied okay.

Under what load what should be the shear what should be the horizontal dual reading and what should be the particle dual reading so which we can measure from the shear box test under different ,loading condition so which I will explain you later.

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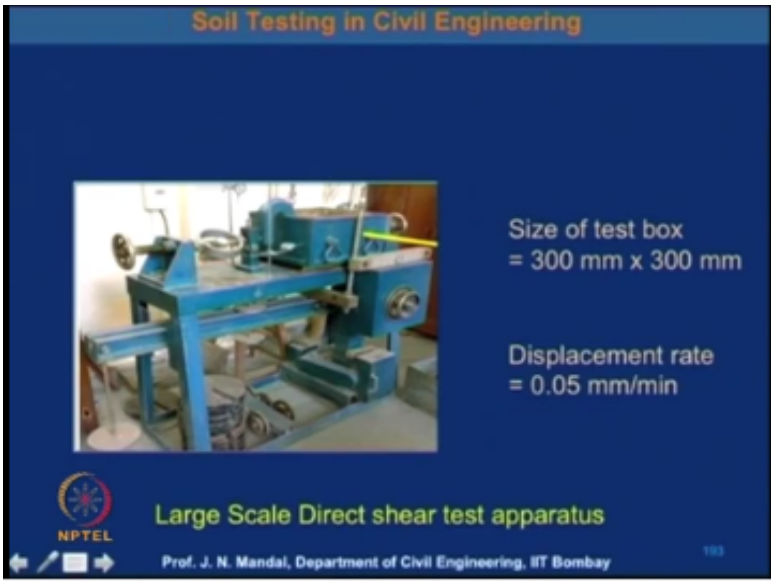

So next also this is laager scale direct shear sometimes you some material which you cannot determine the direct shear test from the smaller scale shear box test with which is 6 cm x 30 you require that large shear scale direct shear test and in the larger scale direct shear test this is the this is your shear box which is about 300mm x 300mm is the size and displacement rate is about 0.05 mm / min so when the soil sample that aggregate this is larger size of the aggregate then we have to perform that is using the larger scale direct scale shear part test.

Or if you wanted to perform ant geo grid material or geo textual material it is always recommended to use the larger scale direct shear test in a state of the smaller scale direct shear test so you can have the appropriate region.

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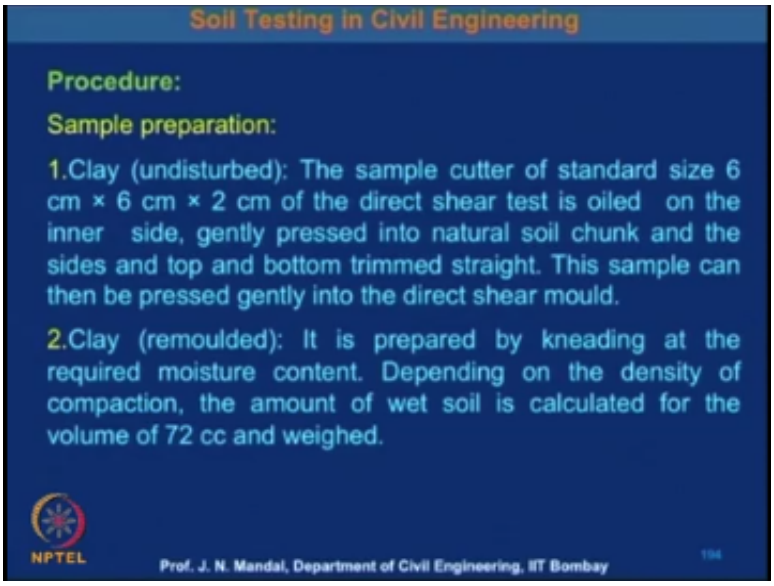

Now how did the procedure call sample preparation that is clear we understand the sample cutter of standard size of 6cm x 6cm into 2 cm of direct shear test is oiled on the inner side gently pressed into natural soil chunk and the sides and top and bottom is timed straight and this sample can then be pressed gently into the direct shear mould if it is a clay remoulded it is prepared by kneading at the required moisture content depending on the density of compaction.

So how much you are compacting the soil sample the amount of wet soil is calculated for the volume of 72 cc and then weighted.

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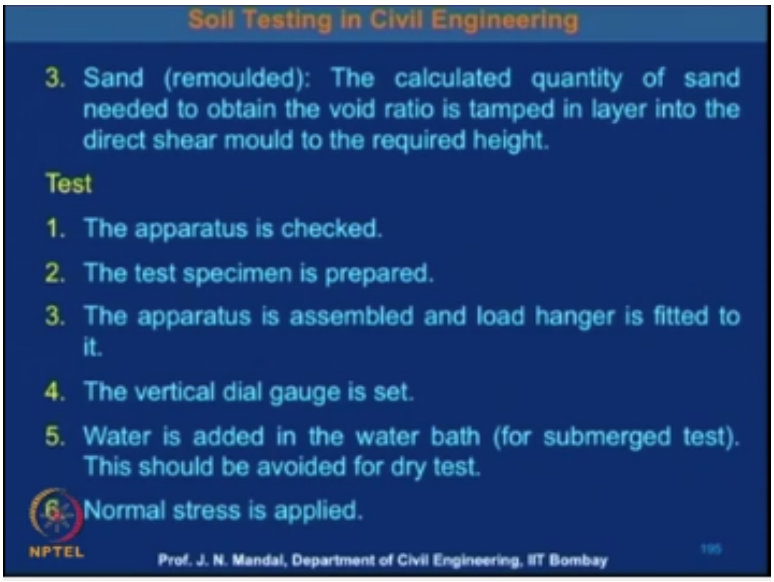

If it is a sand remoulded we calculated quantity of sand needed to obtain the void ratio is tamped in the layer into the direct shear mould to the required height now the test is that you have to check the apparatus is checked then the test specimen is prepared the apparatus is assemble and load hanger is spited then particle dual gauge is set water is added in the water bath for smugger test and this should be avoided for gauged test normal shear test is applied the top up of the box is lifted using lifting screw and shear is applied through the given mechanism the load is removed at the end of the test and box is drained the shear box and the spaceman is removed.

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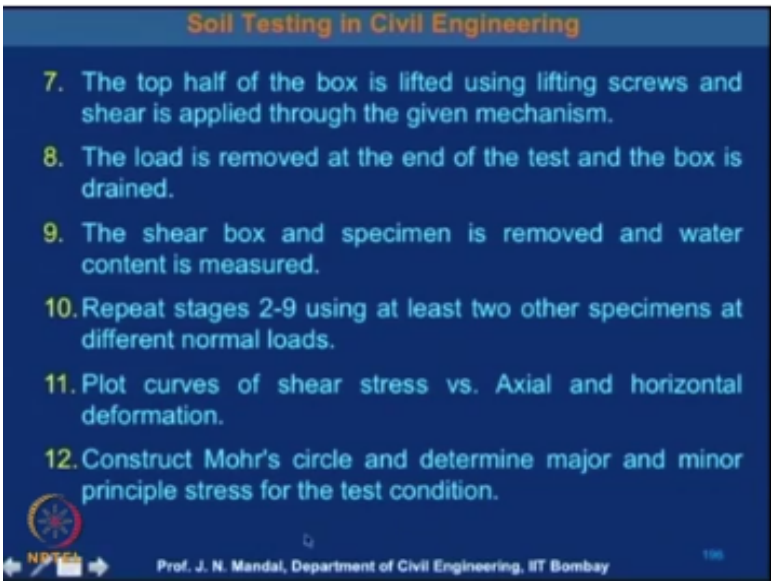

And water contain is measure repeat the stage 2 – 9 using at least two other specimen at the different normal loads then plot curves or shear stage verses axial and the horizontal deformation the construct Mohr's circle and determine the major and the minor principle stress.

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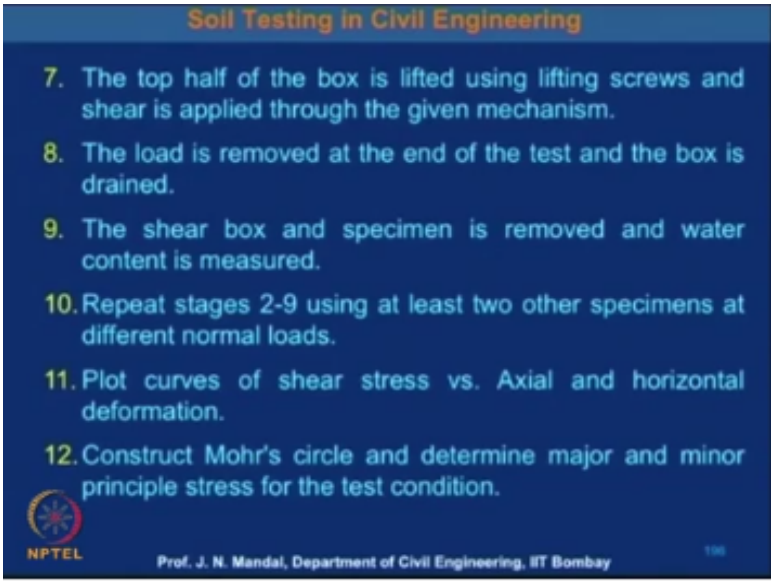

So with this kind of the test you can determined that what should be the shear stress what should be the axial and the horizontal deformation then you determine what will be the major and the minor principles stage under this condition, so this will be very this parameters shear strength parameter will be very useful in geo technical engineering thanks.

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Prof. R. K. Shevgaonkar

Head CDEEP
Prof. V. M. Gadre

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