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# Geotechnical Engineering Laboratory

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**Lecture No-02**

## Specific Gravity and field Density

Now for cohesive soil 50 mm density bottle is used. For coarse grained soil 500 mm flask or pynometer is used. In case of soil with the high percentage of clay it is advisable to use the kerosene either waiting material.

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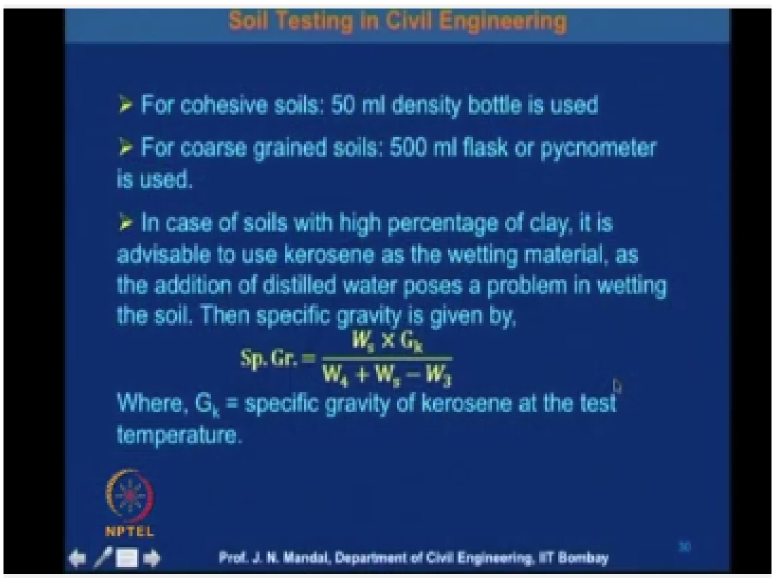


As the addition of distilled water what is the problem in waiting the soil. Then specific gravity is given by equation, specific gravity is equal to $W_s$ x $G_k/W_4 + W_s - W_3$. Here Gk the specific gravity of kerosene at the test temperature. So from this equation also you can determine the specific gravity of the soil.

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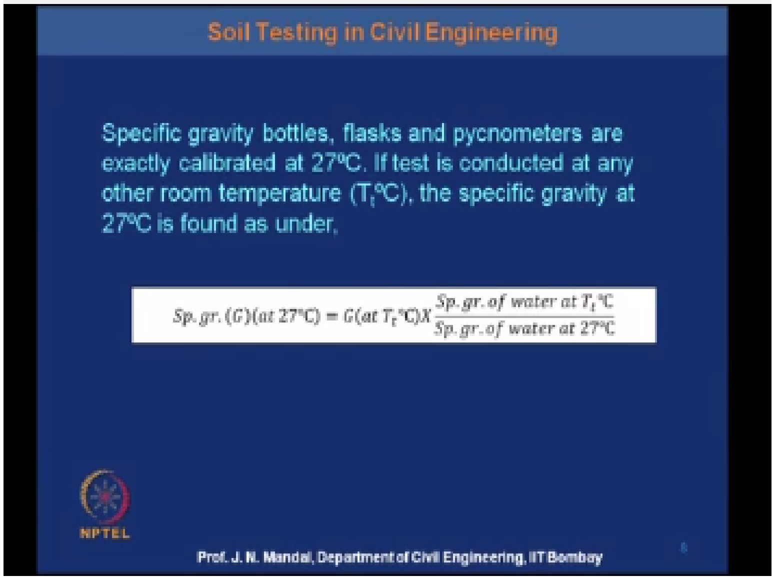


The specific gravity bottle, flask and pynometer are exactly calibrated at 20°C. If the test is conducted at any other room temperature say $T_1$° the specific gravity at 20°C also found with this specific gravity G at temperature of 20°C=G(at $T_1$°C) x specific gravity of the water at T1°C/specific gravity of the water at 20°C. So some calculation on specific gravity test.

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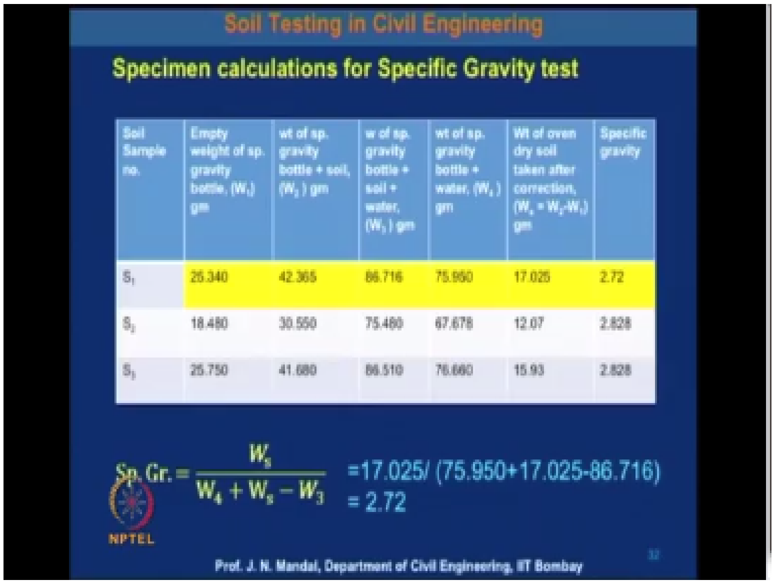


So we can take the different soil sample soil sample number then we take the empty weight of the specific gravity bottle okay, then that into weight is above 25.340.then you take the weight of the specific gravity bottle + soil that is W2 gm is 42.365.Then the specific gravity weight of the specific gravity bottle + soil water W3 in gm is 86.716.the weight of the specific gravity bottle + water W4 gm in 75.960.

Then weight of the even dry soil taken after the correction is Ws=W2-W3 this is 17.025.So we can calculate the specific gravity and this gravity is 2.72. Detailed calculation is given here this specific gravity is equal to Ws/W4+Ws-W3 is 17.025/(75.950+17.250-86.716) this will give you the specific gravity is above 2.72. so we can determine the specific gravity of the soil. And these specific gravity of the soil, generally it is 2.5,2.7,22.8 like this.

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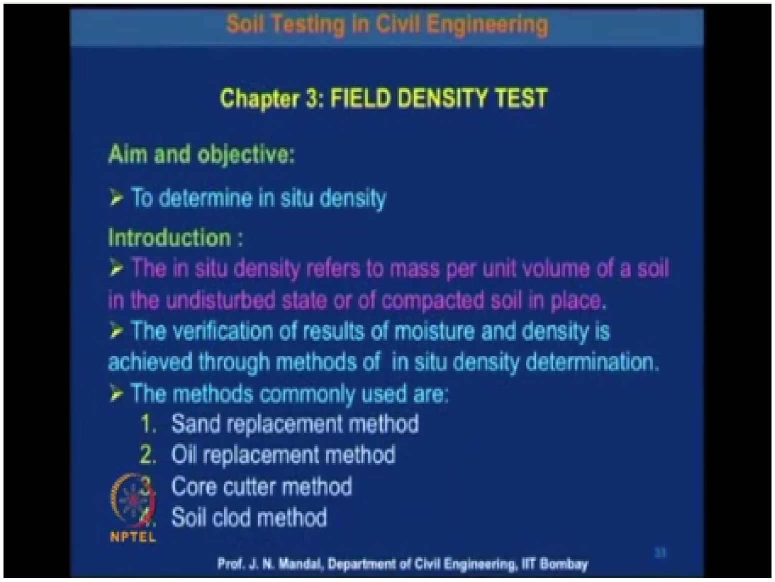


Aim and objective: To determine in situ density. These are very important that how you can determine in situ density f the soil. Now the in situ density refer to mass per unit volume of a soil in the undisturbed state or of compacted soil in place these very important that one should they collect the undisturbed soil sample not the disturb soil. And then the verification of results of moisture and density is achieved through methods of in situ density determination.

The methods commonly used there are defined types of the method, one method is Sand replacement method and second Oil replacement method or core cutter method also very important and then soil clod method, so I just forgot some of the method here what that field density of the soil, the underline the principle of these method is basically same.

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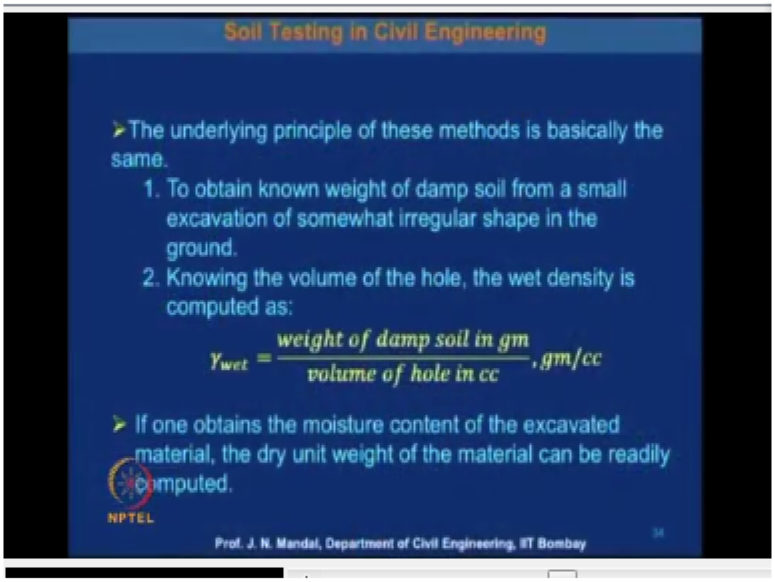


First to obtain known weight of damp soil from a small excavation of somewhat irregular shape in the ground and then knowing the volume of the hole, the wet density is computed as that $\lambda_{wet}$ will be equal to ratio of the weight of damp soul in gm and the volume of the hole in cc that you can determine what will be the weight $\lambda_{wet}$ in units is gm/cc. If one obtain the moisture content of the excavated material.

The dry unit weight of the material can be readily computed if you know the weight density we can also determine the dry density of the soil sample then sand clod method enable determination of the volume of the hole, by filling with sand calibrated for it is unit weight so, it is desirable to have uniform or one size of the sand to avoid the segregation problem. (Generally, sand passing sieve number 20 but retained on sieve number 30 is used).

If the natural soil in the field is very hard and also dry, the core cutter may not penetrate even with hammering. Then what could be done in such a situation problem each best to resolve by taking a soil clod and determining its weight and volume by wax coating method. So these soil we can solve the problem if it is a too hard o define types of the method are available so defined upon the type of the soil we can adopt and can determine the properties of the soil. So for these kind of the testing so we required certain apartment, apparatus and the accessories required. That is Sand Replacement Apparatus we required sand pouring cylinder and I show you sand pouring cylinder and calibrating cylinder and metal tray with the central hole while sand which is standard 4” diameter 100mm diameter post-hole auger then it required Spatula weighting balance to weight up to 10kg with 0.1 gm accuracy.

Then we required Moisture cans we requires Dying oven, core cutter with that dolly and a Light weight hammer and the Screw driver and the straightedge. So these are the mainly that apparatus what you required. I will show you the what you in the slid what are the those apparatus required.

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Here you can see the core cutter and this the sand replacement apparatus and this is the dolly and these are the post-hole auger in its we can  hole into the soil and this is the oven in its we can dry the soil sample and this is the weighting balance we can major and this is the moisture container in its we can keep the soil and we can major the dry weight and the weight of the soil and this is the white standard sand and these are the screw driver its what will be required and this is the light weight hammer which is used for the field density. So these are the apparatus are very important and we use these apparatus for the determination of the field density of the soil.

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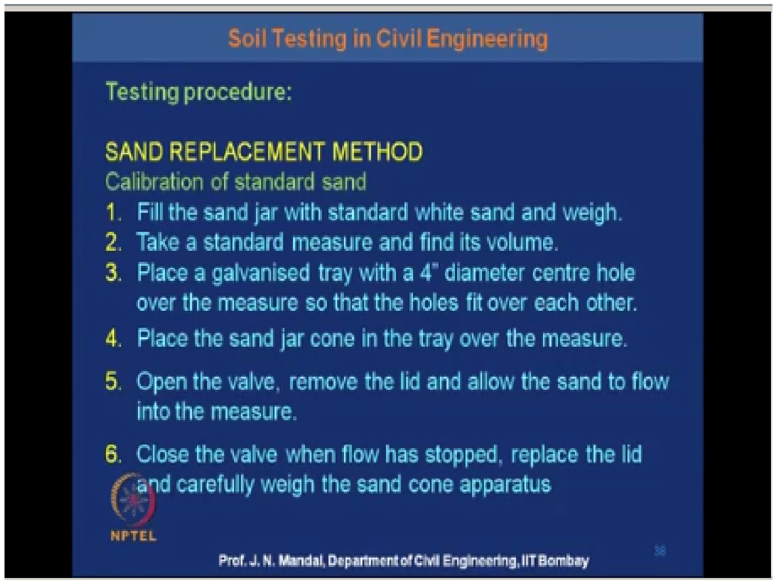


So what are the testing procedural so first of all the sand replacement method he required calibration of the standard sand, fill the sand jar with standard white sand and weigh and I show you that what is the white standard sand so you fill up into the jar and take the weight of the white standard sand and take a standard measure and you can find its volume then, place a galvanized tray with a 4” diameter center hole over the measure so that the hole fit over each other.

Place the sand jar cone in the tray over the measure. Then open the valve, remove the lid and allow the sand to flow into the measure. Now close the valve when flow has stopped, replace the lid and carefully weigh the sand cone apparatus. So these are the weigh that 1” to perform the test.

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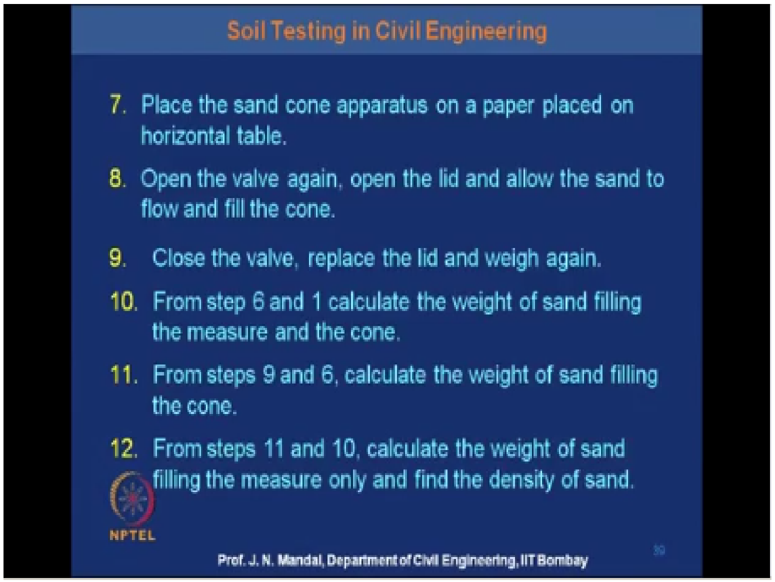


Then place the sand cone apparatus on a paper placed on the horizontal table. Open the valve again, open the lid and allow the sand to flow and fill the cone. Close the valve, replace the lid weigh again. From step 6 and 1 calculate the weight of sand and filling the measure and the cone. From step 9 and 6 you calculate the weight of the sand filling the cone. Form step 11 and 10 calculate the weight of the sand filling the measure only the find the density of sand. So these are the density of the rules for the determination of the density of the soil sample.

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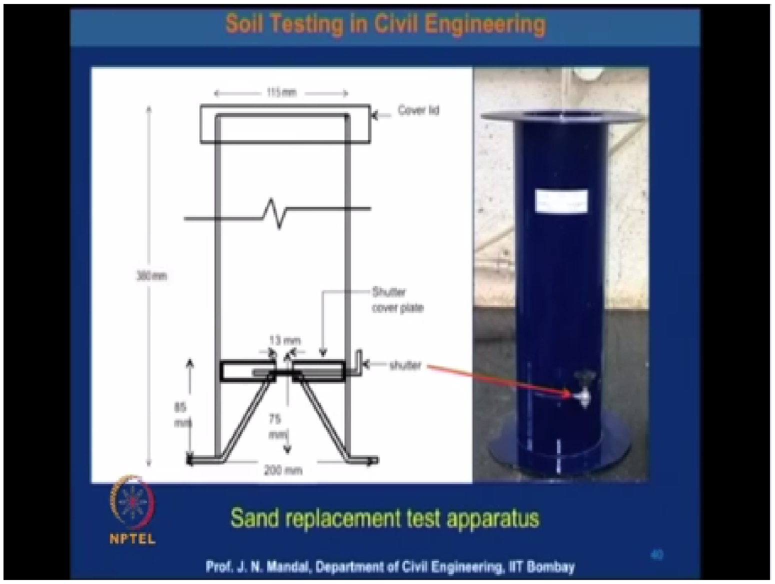


Now here you can see the sand replacement test apparatus and this is the cone these dimensional area is 200mm and this is 8.5 mm and the core cutter it can be replace and it can fill up with the sand and you can measure what should be the volume.

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So this the procedural for calibration of sand, you can see now field test: Level an area of the soil in the open field and place the tray with a 4” diameter or 6” diameter hole on it. With a 4” diameter post auger, bore a hole 5” to 6” okay 125 to 150. And then remove all the material excavated from the hole, and place it in a polyethylene sheet and weigh it to find its weight. Now fill the sand jar cone apparatus with standard sand again and weigh. Place the clean tray on hole place the sand cone apparatus on that. Open the valve, remove the lid and allow the flow into the hole.

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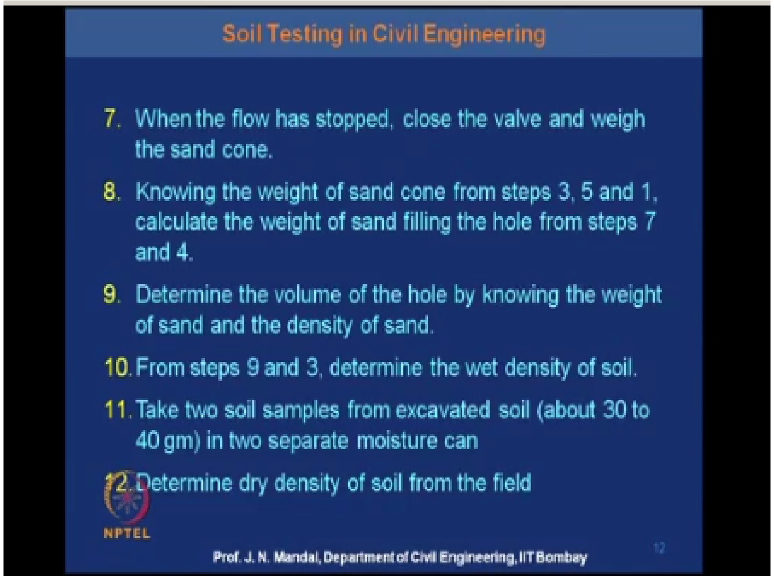


So when the flow has stopped, close the valve and weigh the sand cone. Knowing the weight of sand cone from steps 3, 4 and 1, calculate the weight of sand filling the hole from steps 7 and 4. Determine the volume of the hole by knowing the weight of the sand and density of the sand. So he know that what the volume of the hole he know what the weight of the sand so he can determine the density of the sand. From step 9 and 3, determine the wet density of soil.

Take two soil sample from excavated soil about 30 to 40 gm in two separate moisture can. And determine dry density of the soil from the field. So these are the procedure for the determination of field density by sand replacement method.

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So here you can see the apparatus how you can fill up with sand into this hole and then you can collect it and then it determine that field density of the sand by sand replacement method.

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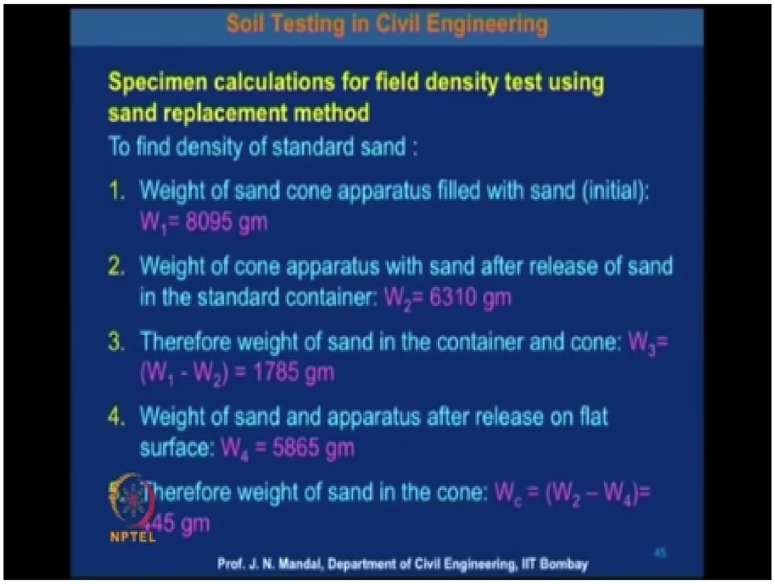


Now specimen calculation for field density test using sand replacement method. So you have to find density of standard sand. First of all it take weight of the sand cone apparatus field with sand initially. Let us see that weight is equal to $W_1$ =8095 gm. Then weight of the cone apparatus with sand after release of sand in the standard container. Let us see weight is $W_2$ =6310 gm.

Therefore weight of the sand container and cone $W_3=(W_1-W_2)$=1785 gm. Then weight of the sand and apparatus after release on flat surface that is $W_4$=5865 gm. So therefore weight of the sand in the cone is $W_c$ = (W2-W4) = 445 gm. So this is just for guessing here that for some specimen calculation for field density of sand replacement method.

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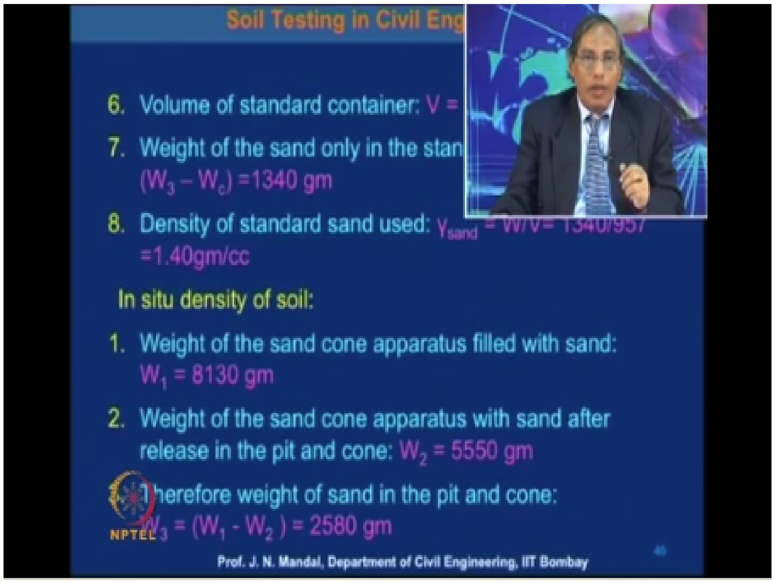


Now you know that what will be the volume of the standard container and that is very standard. Then volume = 957 cc. now weight of the sand only in the standard container W=(W3-Wc) = 1340 gm. Then density of the standard sand used $\psi_{sand}$ = W/V that is W=1340 this divided by that volume is 957 so the density of the standard sand comes 1.40 gm/cc.

In case of in situ density of soil, weight of the sand cone apparatus field with the sand let us see that weight is W1 and that is 8130 gm. Now weight is the sand cone apparatus with sand after release in the pit and cone that is $W_2$ = 5550 gm. Therefore weight of sand in the pit and cone can be calculated $W_3 = (W_1\text{-}W_2\_)$ = 2580 gm.

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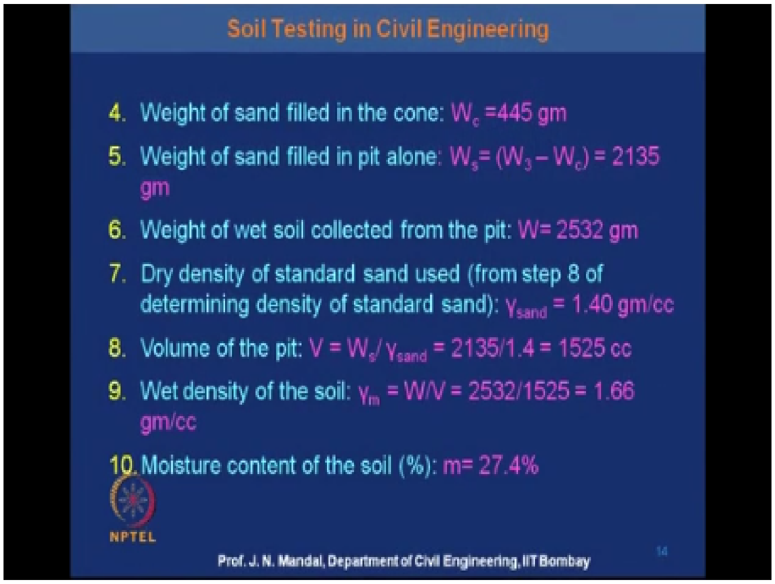


Now weight of the sand filled in the cone is 445 cc. weight of the sand filled in the pit alone is equal to $W_5=(W_3-W_2) = 2135$ gm. Weight if the wet soil collected from the pit that is W=2532 gm. Dry density of standard sand used from the step 8 of determining density of standard sand that is $\psi_{sand}$ you know earlier we determine that is 1.40 gm/cc. so volume of the pit that is $V= W_s/\psi_{sand} =2135/1.4 = 1525$ cc.wet density of the soil that is $\psi_m$ = weight / volume $W/V= 2532/1525=1.66$ gm/cc. Moisture content of soil m is 27.4%.

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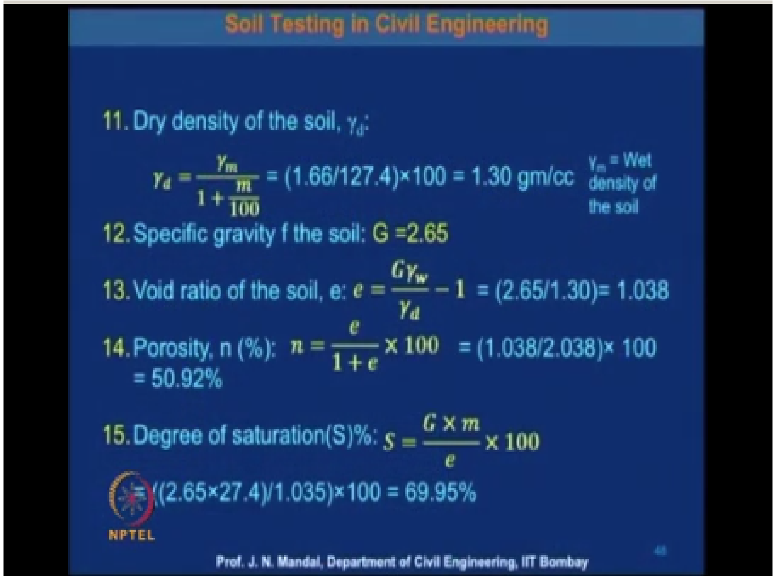


Dry density of the soil, ψd also we can determine the moisture density of soil that mean ψd = $\psi_m$/1=m/100 that means that moisture density is (1.66/127.4)100 and that is 1.30 gm/cc. So ψm is the weight density of the soil. Then specific gravity of the soil we have determine that is G = 2.65. Then form these data dry density and the moisture content and the specific gravity you can calculate what should be the void ratio of the soil.

So, void ratio had the version with the specific gravity and the dry density and the weight density of the soil. So void ratio of the soil e will be equal to G$\psi_w$/ψd-1 we know the density about 2.65 in $\psi_{w1}$/$\psi_d$ 1.30 so it gives the void ratio of the soil about 1.038. Now also we can determine that what should be the porosity of the soil, and porosity is generally generated at n and in % so porosity had the correlation with the void ratio that mean porosity in will be equal to (e/1+e)100 that is (1.038/2.038)100 so porosity in above 50.92%.

So you can determine knowing the value of the moisture content density and the void ratio porosity apart from that you can calculate that what will be the degree of saturation that is S that is also very important parameter. So degree of saturation = (G x M /e) 100 that means we know the what will be (the specific gravity of the soil that is 2.65 moisture contain is 27.4 this divided by the void ratio e = 1.035) x 100 =69.65% so knowing this are density dry density of soil specific gravity of soil so we can calculate that what should be the porosity what should be the void ratio and what should be the degree of saturation. These are all very important parameter which one should know how to evaluate and this will be very match useful for the design of any structure which is based on the soil. So there are other methods also we should called the core cutter method.

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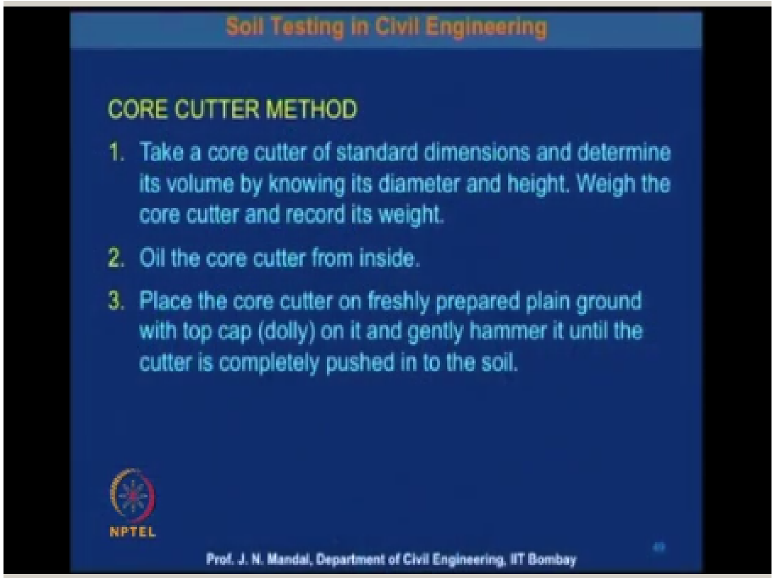


So take a core cutter of standard dimensions and determine its volume by knowing its diameter and height. And weight the core cutter and record is weight. Secondly oil the core cutter from inside and hardly place the core cutter on freshly prepared plain ground with top cap dolly on it and gently harmer it until the cutter is completely pushed in to the soil. Thank you.

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