IIT BOMBAY

NPTEL
NATIONAL PROGRAMME ON
TECHNOLOGY ENHANCED LEARNING

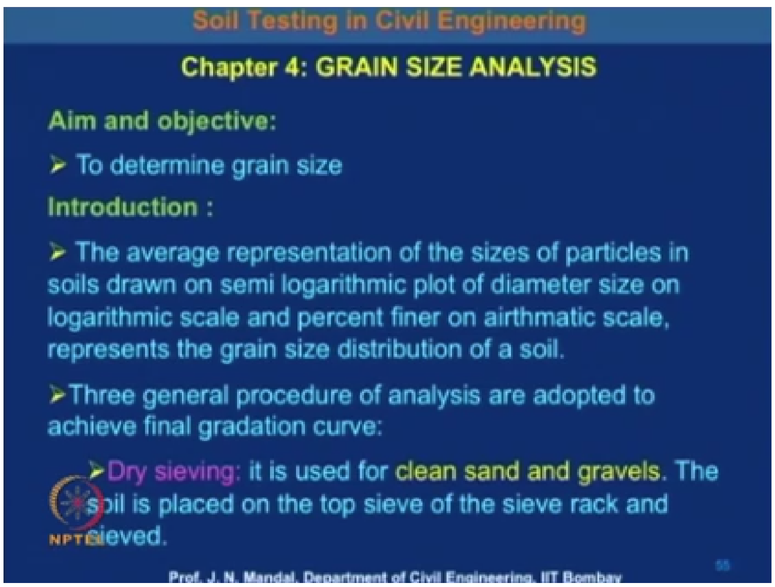
CDEEP IIT BOMBAY

Geotechnical
Engineering
Laboratory

Prof. Jnanendra Nath Mandal
Department of Civil Engineering, IIT Bombay
Lecture No - 04
Grain size analysis

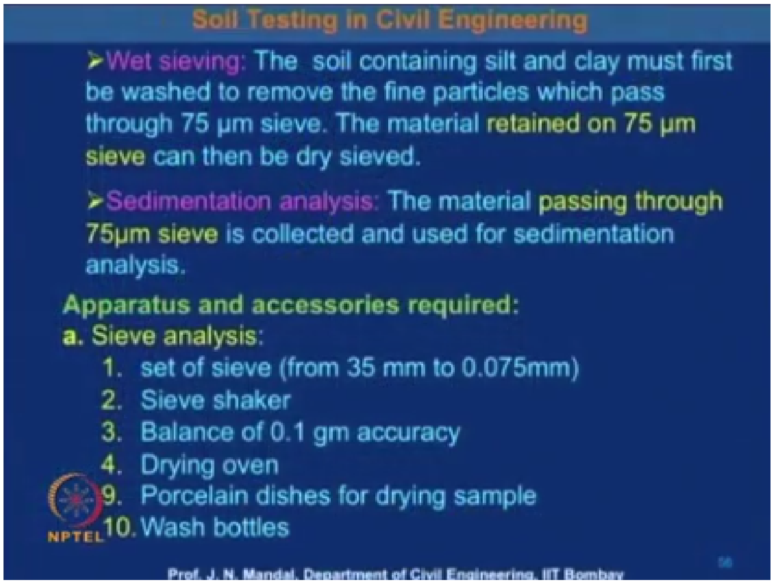
Welcome, I am Prof. Jnanendra Nath Mandal Department of Civil Engineering, Indian Institute of Technology Bombay. I will now teach the grain size analysis of soil, this is very important for every structure that one should know what would be the grain size distribution of the soil. So our main object is how to determine the grain size analysis of the soil.

(Refer Slide Time: 00:59)



The average representative of the sizes of particles in soil drawn on semi logarithm plot of diameter size on the logarithmic scale and percentage finer on arithmetic scale represented the grain size distribution of the soil. Three general procedure of analysis are adopted to achieve the final gradation curve. First of all we will talk the dry sieving in case of the dry sieving it is used for clean sand and gravel. The soil is placed on the top of the sieve of the sieve rack and then shift it.

(Refer Slide Time: 02:14)



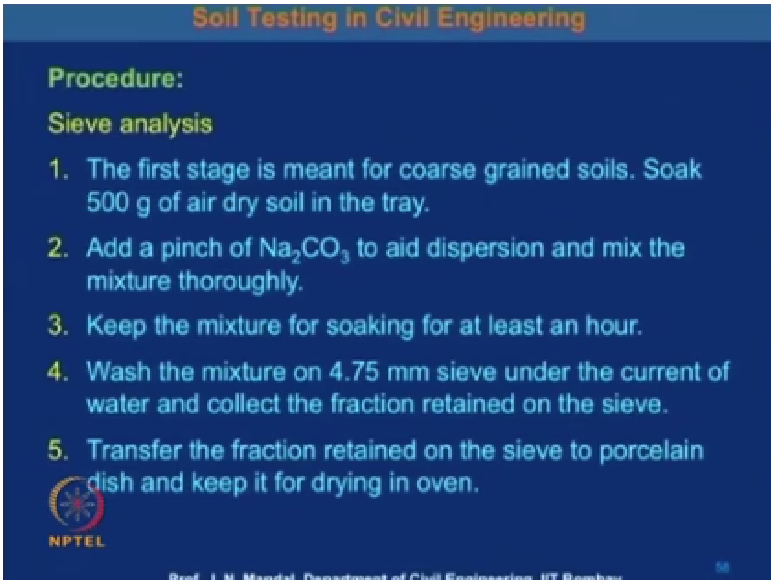
Then wet sieving the soil containing silt and clay must first be washed to remove the fine particles which pass through 75micron sieve. The material retained on 75 micron sieve can then be used for dry sieve. Thirdly, sedimentation analysis in case of sedimentation analysis the material passing through 75 micron sieve is collected and used for sedimentation analysis. Now for this different types of the analysis we require different apparatus and the accessory.

So for the sieve analysis we need set of sieve and with from 35 mm to 0.075mm we require the sieve shaker and the balance of 0.1 gram accuracy then drying oven to dry the soil and porcelain dishes for drying the sample and then wash bottles.

(Refer Slide Time: 04:01)

So here I am showing the different sizes of sieve this is 19mm this is the lid on the top this 19mm, 16mm, 13.2mm, 10mm, 9,5mm, 6.7mm, 4.75mm and then at the end pan, and this is the lid where 2.36mm, 1.12mm, 0.6mm, 0.425mm, 0.212mm, 0.125mm and 0.075mm and then pan this is the sieve shaker in which you can put the sieve here and you shake it for a particular time and this is the wash bottle this is the weighting balance this is the sieve one portion of the sieve is shown here the soil is on the top and this is the porcelain dish which we determine the moisture content of the soil. So these are the accessory are required to perform the set of sieve analysis of the soil.

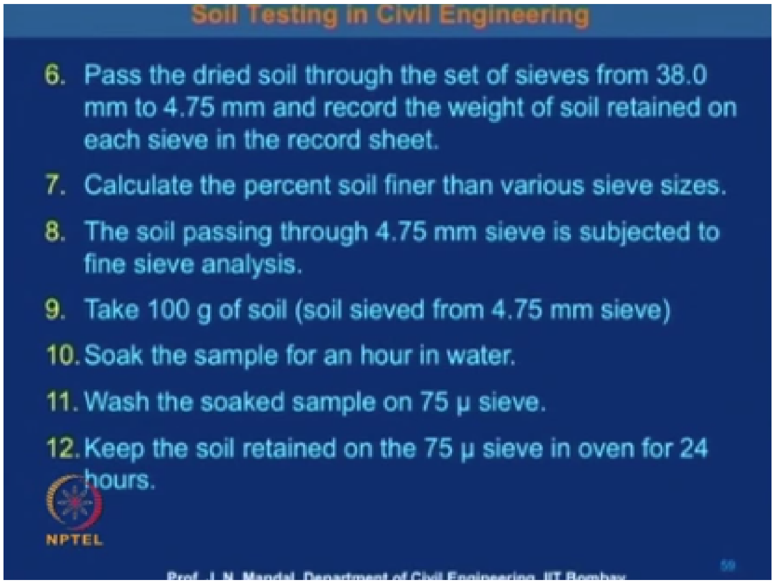
(Refer Slide Time: 05:43)



Now next which talk about the procedure for the sieve analysis, the first stage is meant for coarse grained soil, so we will talk about the coarse grained soil so about 500 grams of air dry soil in the tray. Now you have to add a pinch of sodium carbonate to aid the dispersion and mix the mixture thoroughly, so that is why it is needed to add certain amount of the sodium carbonate on the soil. Keep the mixture for soaking for at least an hour. Wash the mixture on 4.75 mm sieve under the current of water and collect the fraction retained on the sieve.

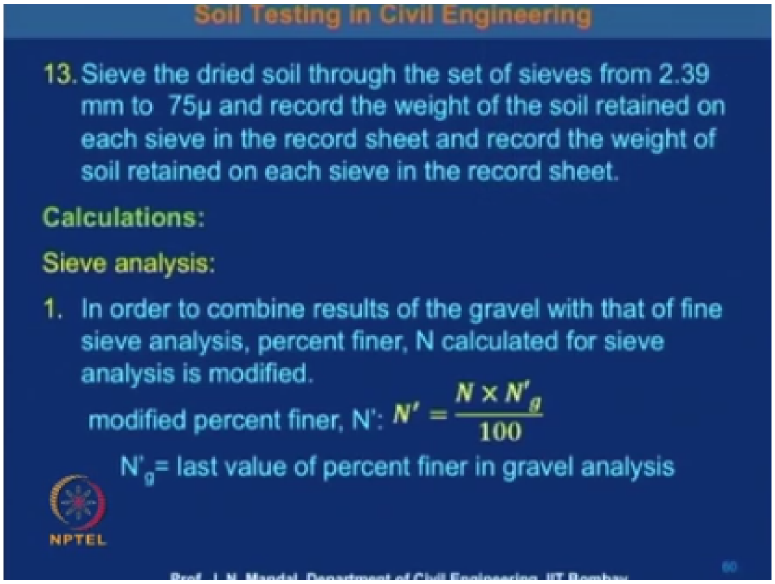
Now transfer the fraction retained on the sieve to porcelain dish and keep it for drying in the oven. So, this is the procedure and then pass the dried soil through set of sieve from 38 mm to 4.75mm.

(Refer Slide Time: 07:27)



As I told you and record the weight of the soil retained on each sieve in the record sheet, then next you have to calculate the percentage soil final then the various sieve sizes. The soil passing through 4.75 mm sieve is subjected to fine sieve analysis. Take the 100 grams of soil, soil sieve from 4.75 mm sieve then soak the sample for an hour in water, wash the soaked sample of 75 micron sieve. Keep the soil retained on the 75 micron sieve in oven for 24 hours.

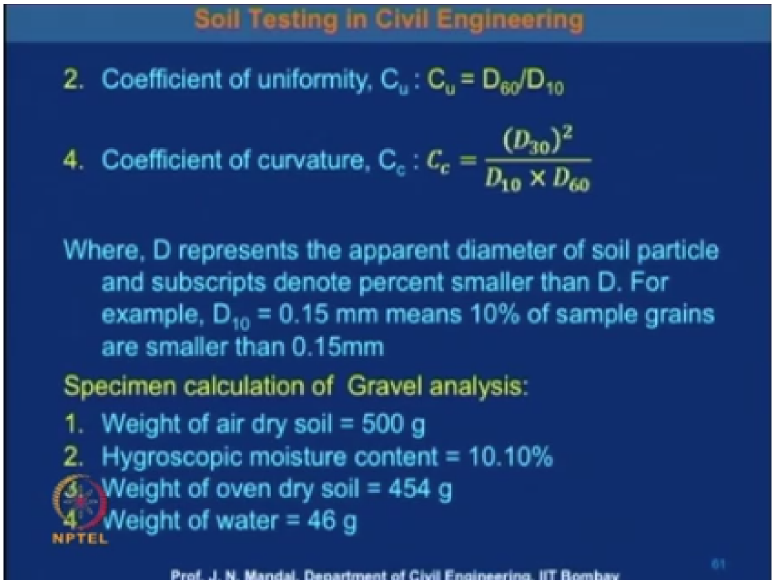
(Refer Slide Time: 08:39)



Sieve the dried soil through the set of sieve from 2.39mm to 75 micron and record the weight of the soil retained on each sieve in the record sheet and record the weight of the soil retained on each sieve in the record sheet. Now how to calculate for the sieve analysis, in one or two combine result of the gravel with that of the fine sieve analysis percentage finer N calculated for the sieve analysis is modified.

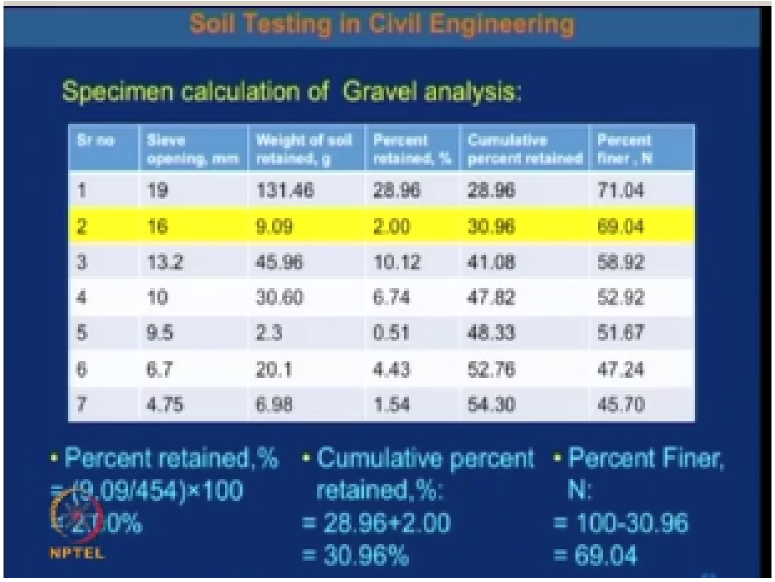
Now modified that percentage finer $N'=Nxn'_g/100$ now N'_g is the last value of percentage finer in the gravel analysis. You can calculate the co-efficient of uniformity.

(Refer Slide Time: 10:16)



That is C_u, $C_u=D_{60}/D_{10}$ you can calculate the co-efficient of curvature that is C_c, $C_c=(D_{30})^2/D_{10}xD_{60}$ here D represents the apparent diameter of soil particle and subscript denote the percent smaller than D. For example, D_{10}=0.15mm means 10% of the sample grains are smaller than 0.15mm. Now how to calculate the specimen calculation for the gravel analysis. So what the specimen calculation for the gravel analysis let us say the weight of the air dry soil is taken above 500g, now hygroscopic moisture content of the soil is 10.10% weight of the over dry sample will be 454g. So weight for water would be 46g. Now this is the some specimen calculation.

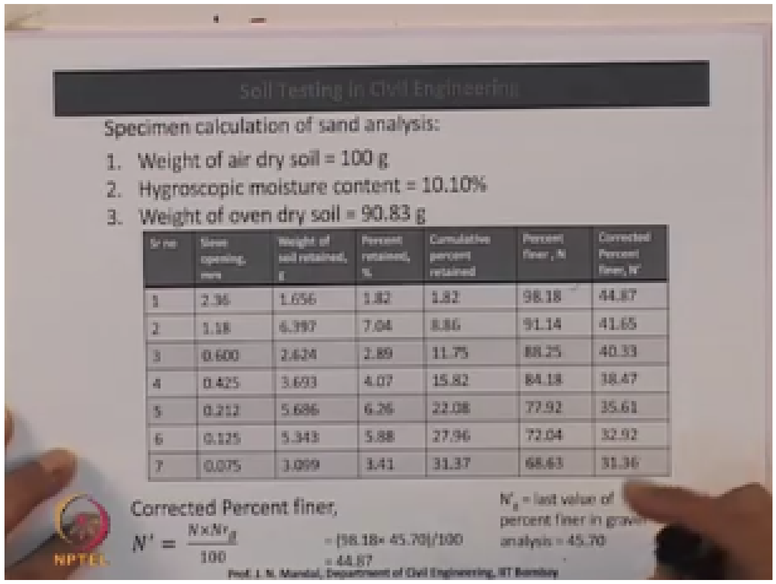
(Refer Slide Time: 12:04)



Sr no	Sieve opening, mm	Weight of soil retained, g	Percent retained, %	Cumulative percent retained	Percent finer, N
1	19	131.46	28.96	28.96	71.04
2	16	9.09	2.00	30.96	69.04
3	13.2	45.96	10.12	41.08	58.92
4	10	30.60	6.74	47.82	52.92
5	9.5	2.3	0.51	48.33	51.67
6	6.7	20.1	4.43	52.76	47.24
7	4.75	6.98	1.54	54.30	45.70

For the gravel analysis so for this specimen calculation for gravel analysis I am showing here.

(Refer Slide Time: 12:18)

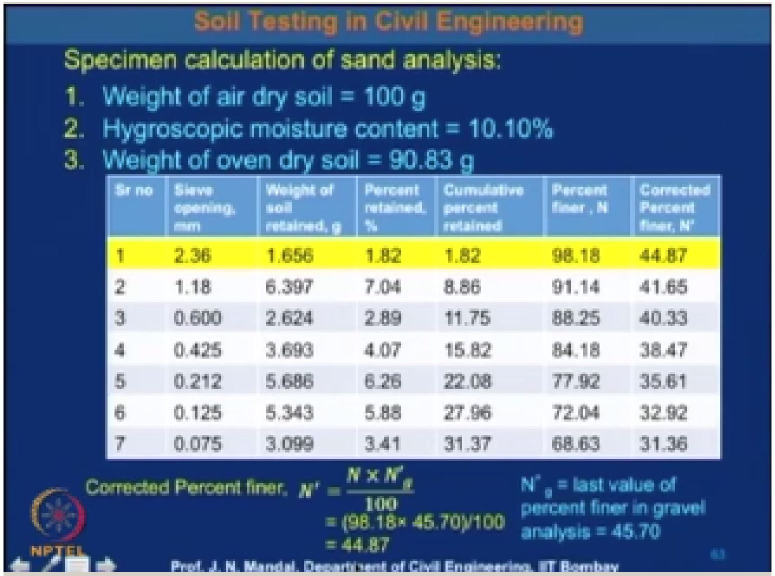


That initially we are taking the weight of the air dry soil, this is a specimen calculation for the gravel analysis this is the sieve opening size that is starting from 19 then 16 then 13.2 then 10, 9.5, 6.7 and 4.75 this is weight of the soil retain 131.46, 9.09, 45.96, 30.60, 2.3, 20.1, and 6.98 and this is the percentage retained is 28.96, 2.00, 10.12, 6.74, 0.51, 4.43, and 1. 54 then we calculate the cumulative percentage retained is 28.96, 30.96, 41.08, 47.82, 48.33, 52.76, and 54.30.

Then we have to calculate what will be the percentage finer that is N, N will be 71.04, 69.04, 58.92, 52.92, 51.67, 47.24, and 45.70. I am showing in one serial number that how you are calculating this. So one example is that what will be the weight of the soil retain is 9.09 now how to calculate the percentage retain, so percentage retain can be calculated thereby this is 9.09this divide by you know that soil retain was 454 so 9.09 /454 x 100 which will give that 2%. So percentage retain is above 2% here.

Now we have calculate the cumulative percentage retain so cumulative percentage retain is here 28.96 + 2% so if you add then it will give 3096%. So this is cumulative percentage retain 30.96%. Then we have to calculate what will be the percentage finer N, so Percentage Finer N will be the 100 – 30.96 it will be 69.04%, so this is the percentage finer for the calculation for the gravel analysis. So like that you can calculate for the other sieve opening side and correspondingly you can also calculate what the percentage is finer.

(Refer Slide Time: 16:09)



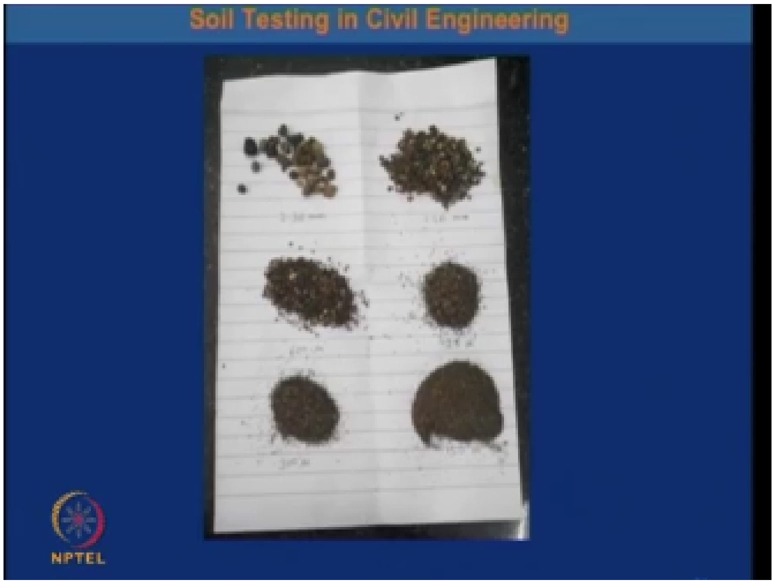
This is one specimen calculation for sand analysis let us say that weight of the air dry soil is 100gram weight of the air dry soil is 100g, and the hygroscopic moisture content is 10.10% so weight of the over dry soil is 90.83g now this is the sieve opening in mm 2.36, 1.18, 0.600, 0.425, 0.212, 0.125 and 0.075. Now weight of the soil retain in grams is 1.656, 6.397, 2.624, 3.693, 5.686, 5.343, and 3.099.

Now what will be the percentage retain in percentage say 1.82, 7.04, 2.89, 4.07, 6.26, 5.88, 3.41 then cumulative percentage retain 1.82, 8.86, 11.75, 15.82, 22.08, 27.96, and 31.37, so percentage finer N would be equal to 98.18, 98.14, 88.25, 84.18, 77.92, 72.04 and 68.63. Now we have to determine what will be the corrected percentage finer that N' so N' is 44.87, 41, 65, 40.33, 38.47, 35.61, 32.92, and 31.36 now we know that how to form the sieve opening size you know that how to calculate the weight of the soil retain you know that what will be percentage retain you know that what will be the cumulative percentage retain.
Also you know how to calculate the percentage finer. Now you have to calculate that what will be the corrected percentage finer that is N', so corrected percentage finer N' can be calculated this N x N'g/`100 so where N' is the last value of the percentage finer in the gravel analysis that is 45.70 so this is you can see this is the specimen calculation for the gravel analysis and this last value percentage finer that is N is 45.70.

So this is the last value we have to take in to consider or the determination of the corrected percentage finer. So corrected percentage finer N'= N xN'g, that means this N'g is 45.70 and N

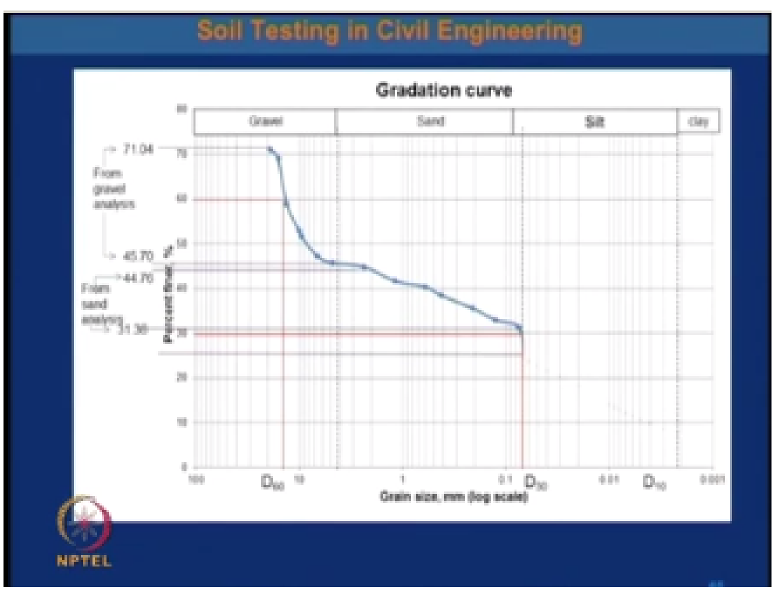
= this is percentage finer that is 98.18 , so N 98.18 x N’g and the last value for earlier gravel analysis that is 45.70/100 this will give you 44.87. This is the corrected percentage finer that is N’.

(Refer Slide Time: 20:36)



So this is the different type of the soil specimen that after that for that analysis so you can see some soil as the finer sand soil as the core sand and at the end.

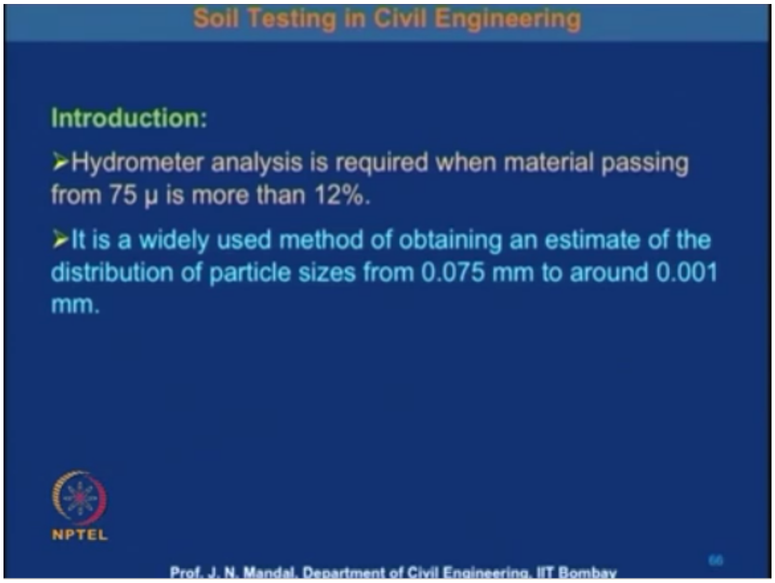
(Refer Slide Time: 20:57)



You have to draw the curve between the grain size and the percentage finer so here it is the gradation curve and this axis the grain size in mm this is in long scale okay it is starting point 0.001 to 100 and this y axis is the percentage finer. So this part we have calculated from the gravel analysis and this part we have calculated of the sand analysis so this is the curve or the gravel analysis and this is the curve for the sand analysis.

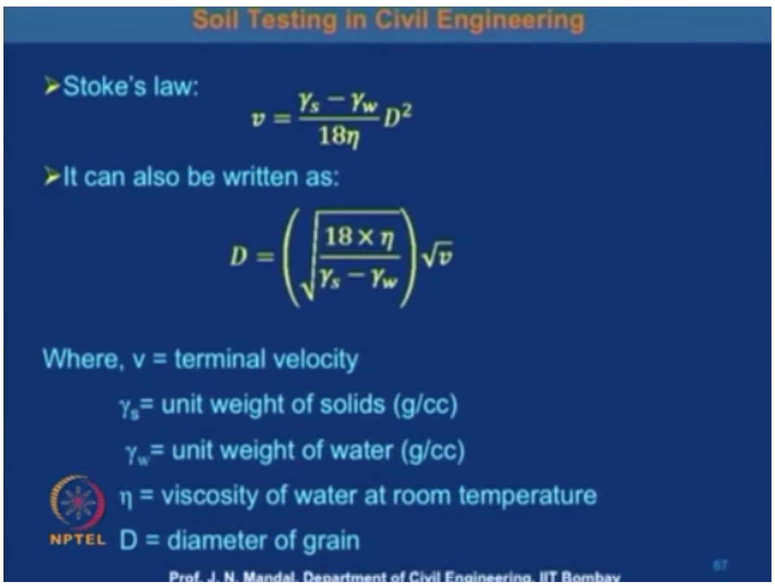
So you know that what will be the percentage of the finer you know the what will be the grain size or the sample so you can draw the grain size distribution curve or the gravel analysis and the sand analysis. So this is we do to dram the decent card the size sample so next we will discussed the hydrometer analysis and that is the required.

(Refer Slide Time: 22:37)



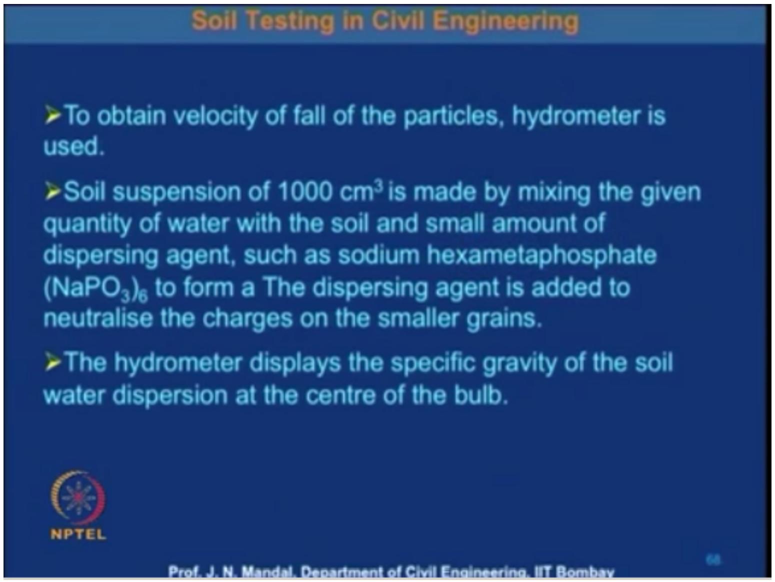
Passing from the 75 micron is more than 12 percentages so it is widely used method of obtaining and estimate of the distribution of the particle size from 0.0075 mm to around 0.001 mm. for the hydrometer analysis in the specific case. For the analysis we are equal and the law.

(Refer Slide Time: 23:20)



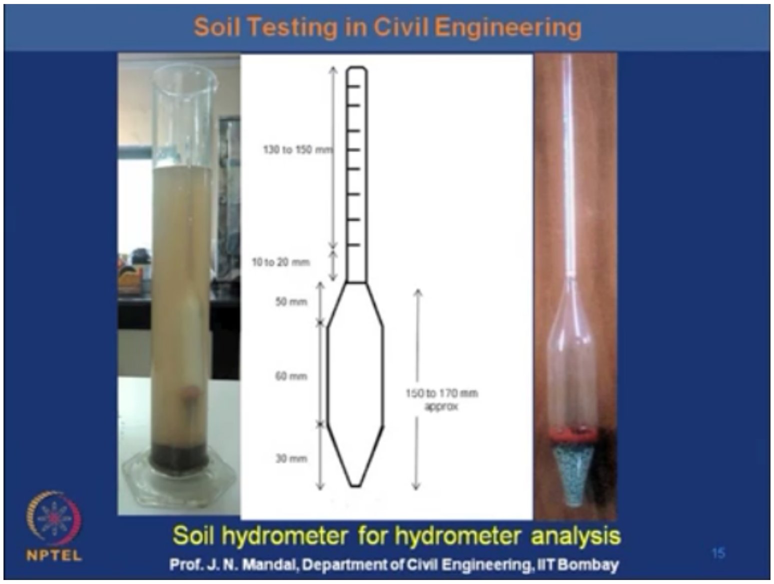
That we say the stokes law so we should know that the stokes law okay so stokes law Is the terminal velocity it is equal to also can be repeated in this form that is d =to 18 *18 /d it is the terminal velocity and this will the w and the meet of the water and the cc and the quit of the solid that is gram per cc and this is q is respectively water and this did is the diameter so form this equation you can calculate with the diameter of the okay you use the strokes law from which we can determine the diameter of the grains .

(Refer Slide Time: 25:09)



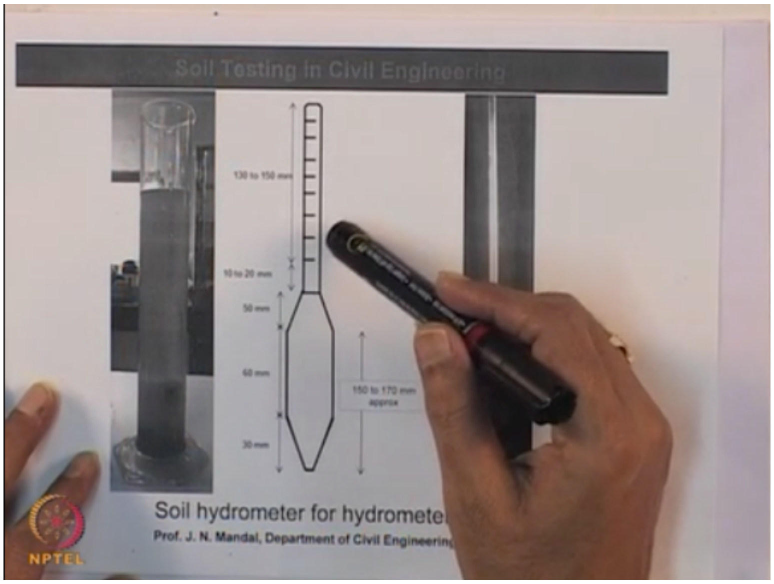
To obtain the velocity of the all the particle hydrometer is internally use so soil suspension of about one third cm is made by the mixing the given quantity of water with the soil and small amount of dispersing sodium hexes metro politic to form dispersing agent to neutralize that charges on the smallest particle of the grain the hydrometer is also displaced the specifies gravity of the soil water this person at the centre of the valve. I will show you the centre of the so this is the soil hydrometer analysis and this is the hydrometer analysis.

(Refer Slide Time: 26:34)



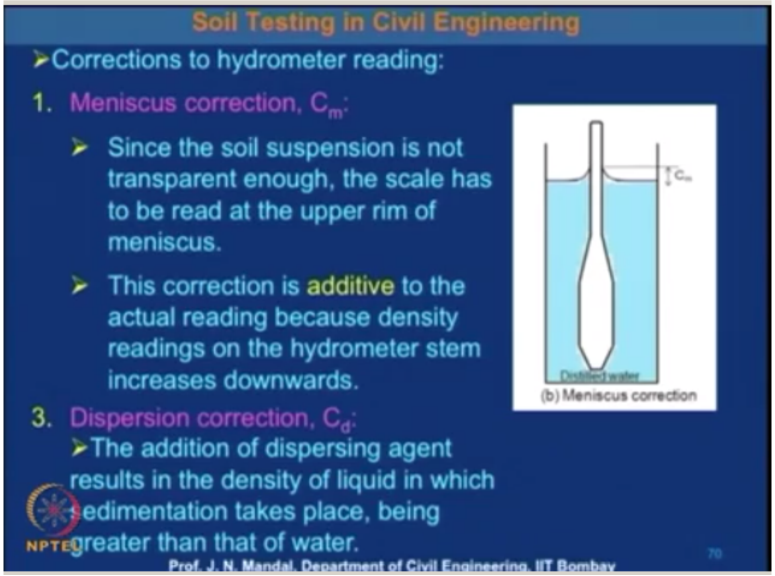
And what are the soils and this is the hydrometer and this is the reading to read the hydrometer here so this is the hydrometer and this hydrometer.

(Refer Slide Time: 26:51)



Form here about 132 to 150 mm and this is one about 170 approximate and this is 30 mm and this 60 mm and thi9s 50 mime and to form here and term to t so this is the soil hydrometer and analysis will you use these hydrometer the determination gain side of the soil so the without the hydrometer we required the some correction to the hydrometer.

(Refer Slide Time: 27:49)



So the first correction is the minute's correction that we marinated and came since the soil correction is suspension is not transparent enough this case has to be read the apart need of the mini caste this upper case of the mini case here to read I you keep the value to the this is the hydrometer this is the water and this is ca is which you have to major the upper of the meniscus now these kind of correction is additive to the ax tall reading because the density reviewing in the hydrometer steam increase review in the .

Now there is a dispersed correction that is immigrated at cad because the addition of the dispersing agent this is the density of the liquid in which the sedimentation takes place being the data water so this dispersion correction also needed so to obtain in the dispersing Correction and the Centimeter cube of the dispersing agent in the solution is taken in a standard major cylinder and the balloon is made equal to send meter cube /adding the distilled water.

Now this is the a cylinder okay that is about and then the distilled water and the hydrometer and then hydrometer Is insisted and the reading is taken this reading hydrometer is insert it in the standard major filled with the water and the reading is taken so difference between the two reading is the disposing the two agent the collection.

So one time we have to take with the simply distilled water and the ocher time we have to take with the dispersing agent and then you take the difference between the reading which we will give you the dispersing agent correction so it is alive subtract it from the hydrometer reading upward it is a corrected meniscus. So these are the correction required for this analysis apart from that is the temperature correction that is denote at ct the hydrometer reading is calculated gnarly at the temperature of 27° C from the temperature is get full quarter and note the hydrometer d for corresponding the temperature at the integral of 2 up is more than 27 centigrade then the suspension is lighter is at all composite correction and is equal to cal cp and ct thank you.

NPTEL
Principal Investigator
IIT Bombay

Prof. R.K Shevgaonkar

Head CDEEP

Prof. V.M Gadre

Producer

Arun Kalwankar

Digital Video Cameraman

&Graphics Designer

Amin B Shaikh

Online Editor

&Digital Video Editor

Tushar Deshpande

Jr. Technical Assistant

Vijay Kedare

Teaching Assistants

Arijit Roy

G Kamalakshi

Sr. Web Designer

Bharati Sakpal

Research Assistant

Riya Surange

Sr. Web Designer

Bharati M. Sarang

Web Designer

Nisha Thakur

Project Attendant

Ravi Paswan

Vinayak Raut

ENHANCED LEARNING

(NPTEL)