Geosynthetics Testing Laboratory

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Lecture - 14
Hydraulic Properties and abrasion Test of geosynthetics

So, next we will show you the permittivity that equipment in which you will determine the test permittivity. So, this equipment is the full length in plane flow. So, now, we will show you the equipment how you can determine the transmittivity of the geosynthetics material.

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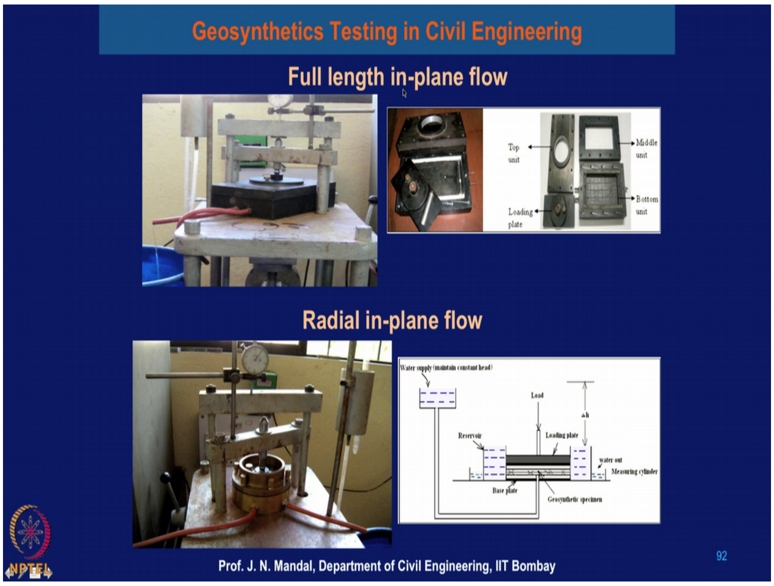

So this is the, your full length in plane flow. And here the size of the sample will be 200 divided by 100 millimeter, which is located in between the 2 plate and then you are applying the load. And, then you are measuring the, what will be the height? So, this is the kind of the equipment we used for the determination of the full length in plane flow.

On the other way also we can determine that what is will be the permittivity transmittivity of the geosynthetics using the radial in plane flow? So, this is from the center the water is passing radially ok. So, this is the kind of geosynthetics material is here and this from the center water is passing and going through radially. And then you can see the (Refer Time: 01:48) difference and then you can determine, what is will be the transmittivity of the geosynthetics material using the radial in plane flow, because in case of transmittivity water will pass along the plane of the geosynthetics material.

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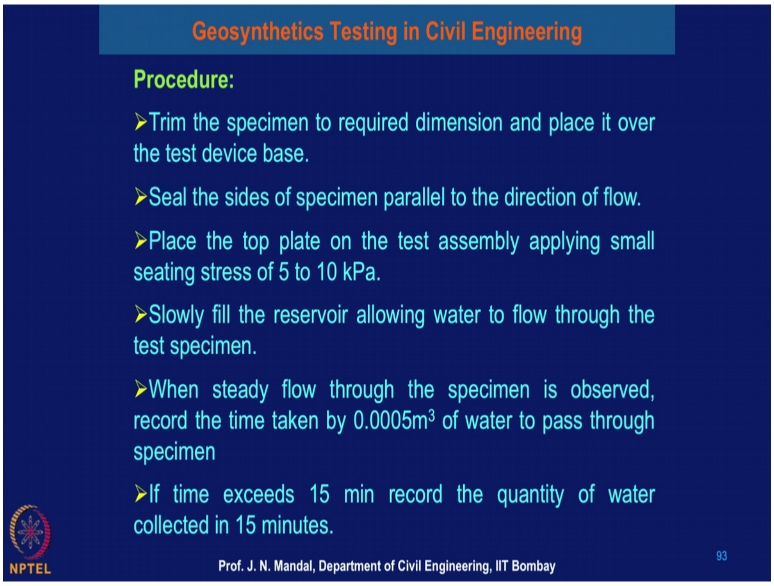

So, procedure that trim the specimen to required dimension and place it over the test device and device base, and then seal the side of the specimen parallel to the direction of the flow; And place the top plate on the text assembly applying the small seating stress of 5 to 10 kilo Pascal. Slowly fill the reservoir allowing the water to flow through the test specimen. When the steady flow through the specimen is observed record the time taken by 0.005 meter cube of water to pass through the specimen, if the time exceeds that 15 minutes record the quantity of water collected in 15 minutes.

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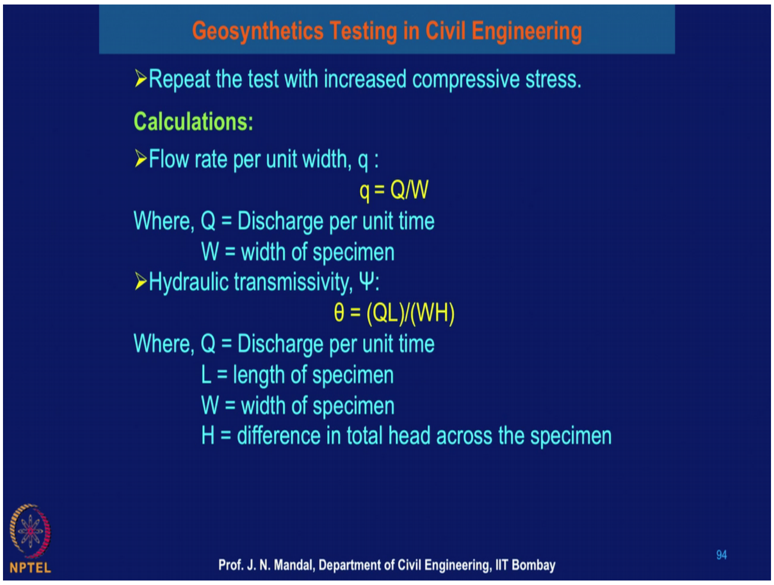

So, you can repeat that test with increased compressive stress and then you can calculate, what will be the flow rate per unit width q is equal to capital Q by W. Where capital Q is the discharge per unit time and W is the width of the specimen. So, hydraulic transmissivity sin theta is equal to Q into L divided by w into h, where Q is the discharge per unit time, L is the length of the specimen, W is the width of the specimen and h is the differences in the total head across the specimen.

So, if you know what will be the quantity of water, you know the, what will be the length of the specimen. And, also equally know what will be the width of the specimen and what will be the difference in the hydraulic head of the specimen range, you can calculate the what is will be the hydraulic trasmittivity of the geosynthetics material?

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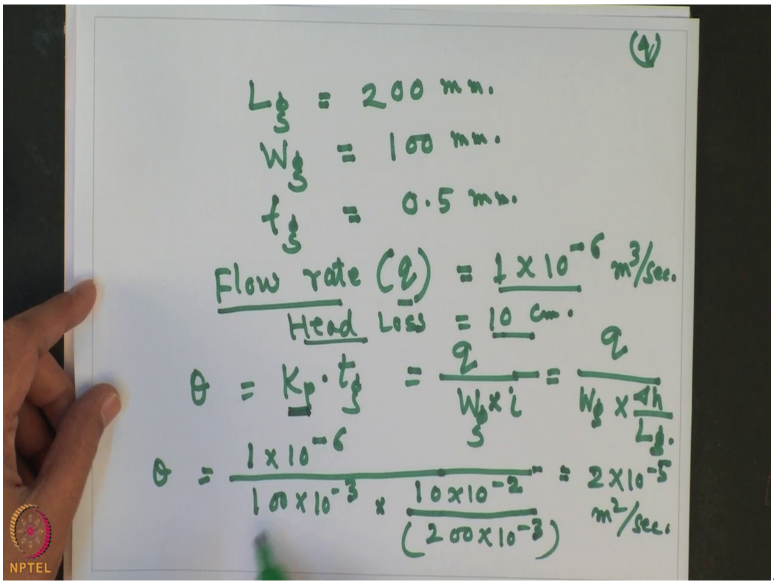

For an example, in a one specimen calculation, that if the length of the sample of the geosynthetic material let us say L of g is equal to 200 millimeter. And width of the sample let us say, which is designated as W of g. So, this is equal to 100 millimeter. And, the thickness of the geosynthetics material let us say t of g is equal to 0.5 millimeter. So, you have to determine what will be the flow rate that mean flow rate is equal to q you can measure flow rate is equal one into 10 to the power minus 6 meter cube per second.

So, you are measuring the flow rate when you know the, what will be the quantity of water collected at a particular time? So, you know the, what will be the volume of water collected in the reservoir for a particular time. So, you will be knowing what will be the flow rate that is q. And, let us say that head loss head loss is equal to 10 centimeter. So, you know the equation theta is equal to K p into t of g is equal to q divided by W into i again this is equal to q divided by this is W of g. So, this is W of g into delta of h divided by L of g.

So, theta is q is equal to flow rate that is 1.10 to the power 1 into 10 to the power minus 6 that is q. This divided by W of g w of g is equal to 100 this is 100 into let us say 10 to the power minus 3 into delta of h. So, here that this is about head loss is 10. So, this you can write 10 into 10 to the power minus 2 all in terms of the meter and this divided by L of g. So, L of g is 200 millimeter. So, this will be equal to 200 into 10 to the power minus 3. So, this will give you 2 into 10 to the power minus 5 meter square per second. So, ultimately you can determine what should be the K of p K of p. So, K p will be equal to your theta divided by t of g.

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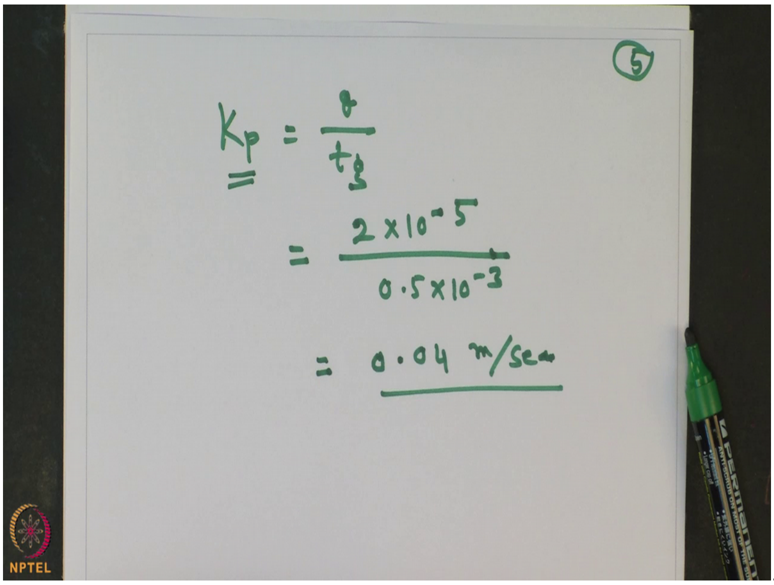

So, we can write K of p is equal to theta divided by t of g. So, this theta is you know 2 into 10 to the power minus 5. And, this divided by t g theta is 2 into 10 to the power minus 5 this divided by t of g t is 0.5 millimeter. So, you can write 0.5 into 10 to the power minus 3. So, this will give you that K p value 0.04 meter per second meter per second. So, you can determine that what should be the transmittivity of the geosynthetics material? So, this is the transmittivity of the geosynthetics material is 0.04 meter per second. And, unit is meter per second. In case of permittivity unit is per second in case of tansmittivity unit is meter per second.

So, you can determine what should be the permittivity of the geosynthetics material? So, there are two important one is the filtration when you will use the term that what is called the permittivity of the geosynthesis material, when the water flow across the plane of the geosynthetics material. So, you can determine what is theta? And, unit is per second and in case transmittivity, when the water flow along the plain of the geosynthetics material and you can determine what will be the transmittivity of the geosynthetics material. And, unit of transmittivity is meter per second.

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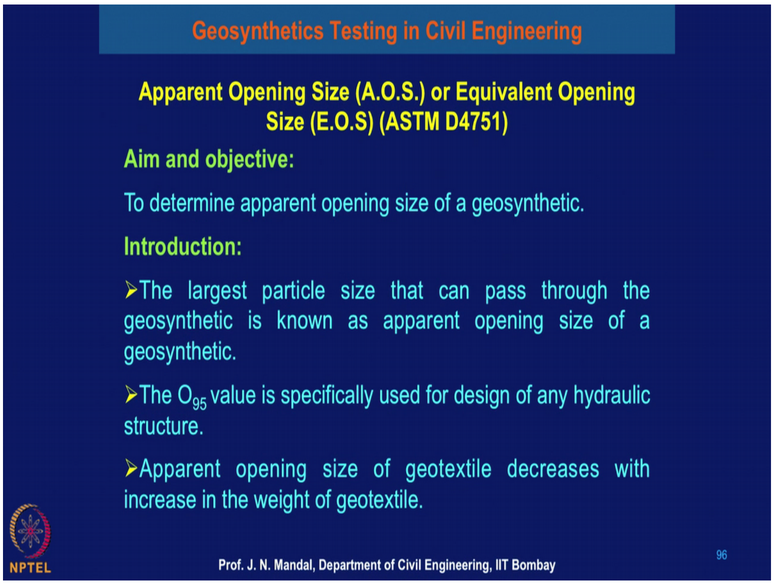

So, next we will discuss the apparent opening size or AOS or equivalent opening size of the geosynthetics material this is as for ASTM D4751. And, this is very important the apparent opening size is you should know that how much quantity can pass through the geosyntheics material? And, how much material can retain in the geosynthetics material? So, it is excusably used for the filtration and drainage and this is very important test to perform the apparent opening size of the geosynthetics material.

So, main objective of this test to determine the apparent opening size of a geosynthetics, the largest particle size that can pass through the geosynthetics is known as the apparent opening size of a geosynthetics. The O 95 is specifically used for the design for any hydraulic structure. Apparent opening size of the geotextile decrease, with the increase the weight of the geotextile material.

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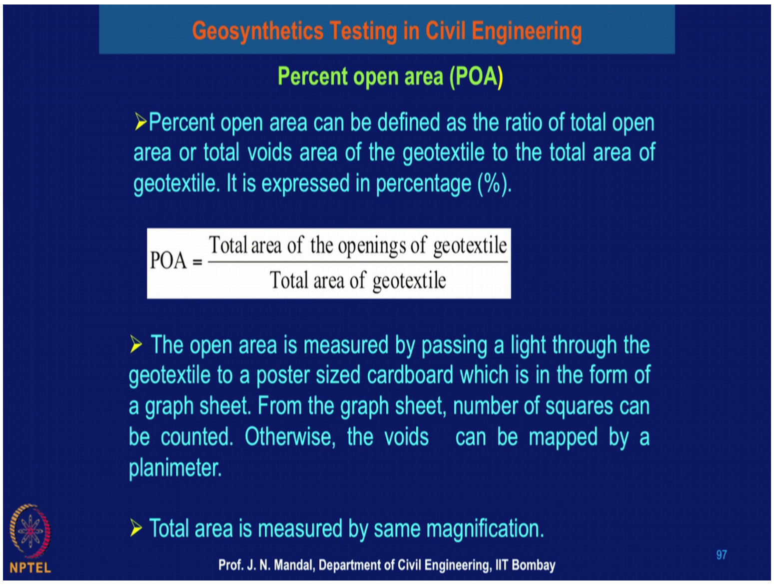

So, you can draw a also that correlation between the apparent opening size of the geosynthetics, you know what will be the particle and what will be the O 95 value from the gain size distribution and then you determine, what is apparent opening size of the geosynthetics material? I can show you that one that this is the for example, that.

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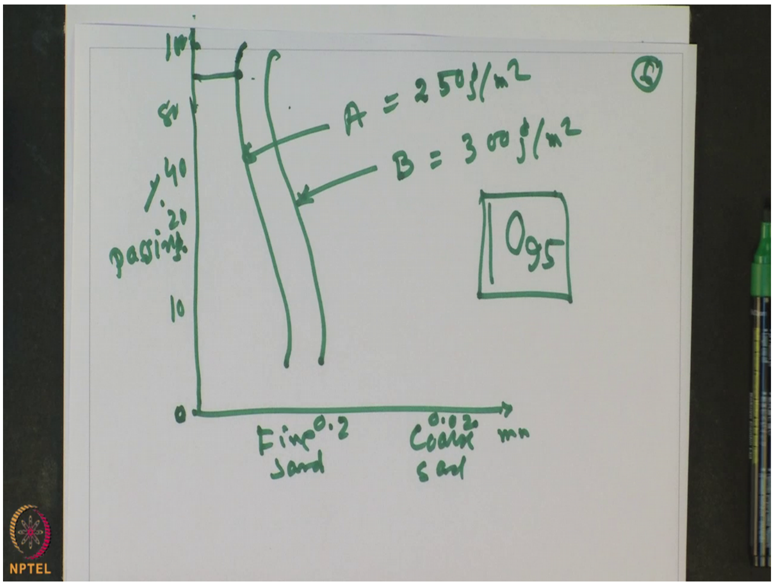

This is the percentage of percentage passing as you know for gain size distribution curve ok. And, let us say this is 0 10 20 40 like that let us say eighty let us say 100 like this. And, this is the millimetre this is maybe that you are fine sand or it may be the coarse sand let us say 0.2 0.02. So, you can have the curve like this you can have the curve like this. For different types of the geosynthtics material, let us say this is A this is B material. And, let us say this weight of this material 250 gram per meter square and B material weight let us say 300 gram per meter square.

So, from this curve what the 95 percentage is will give you that what you call the O 95, this is very important O 95 percent of the value written. So, then you can determine what will be the apparent opening size or equivalent opening size of the geosynthetics material? And, these apparent opening size of the geosynthetics vary from different types of the geosynthetics material.

Now, we will discuss that percent opening size. So, percent opening open area can be defined as the ratio of the total open area or the total wide area of the geotextile to the total area of the textile material. So, it is expressed in terms of the percentage. So, percent open area is designated as POA that is total area of the opening of geotextile divided by total area of geotextile. The open area is measured by passing a light through the geotextile to a poster sized cardboard, which is in the form of a graph sheet. And from the graph sheet number square can be counted otherwise the void can be mapped by a planimeter. So, total area is measured by the same magnification.

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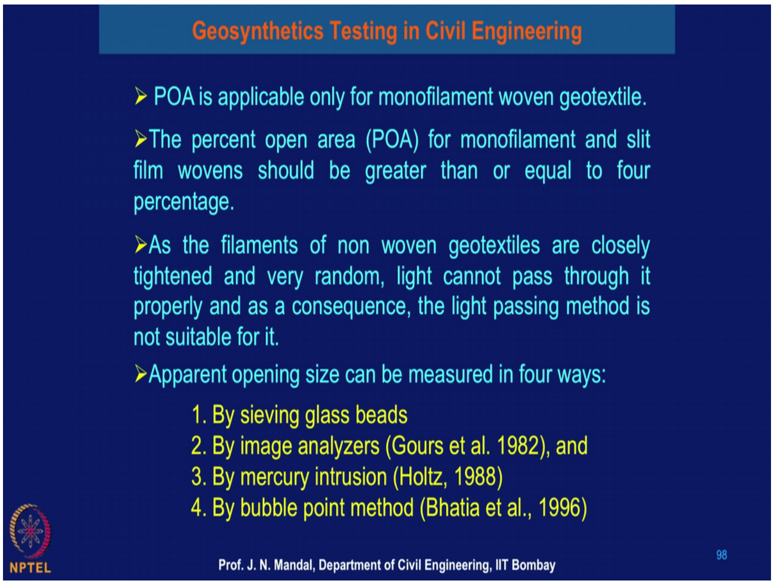

And, next that POA percent open area is applicable only for monofilament woven geotextile material. The percent open area for monofilament and slit film woven should be greater than or equal to 4 percentage. As the filament of non woven geotextiles are closely tightened and very random, light cannot pass through it properly and as a consequence, the light passing method is not suitable for it.

So, there are different types of the method in which we can determine apparent opening size can be measured in the 4 way 1 by sieving the glass beads or by image analyzers that is given by Gours et al about 1982, and by mercury intrusion that is given by Holtz 1998 and by bubble point method that is Bhatia 1996; So, different types of the method to determine the opening size.

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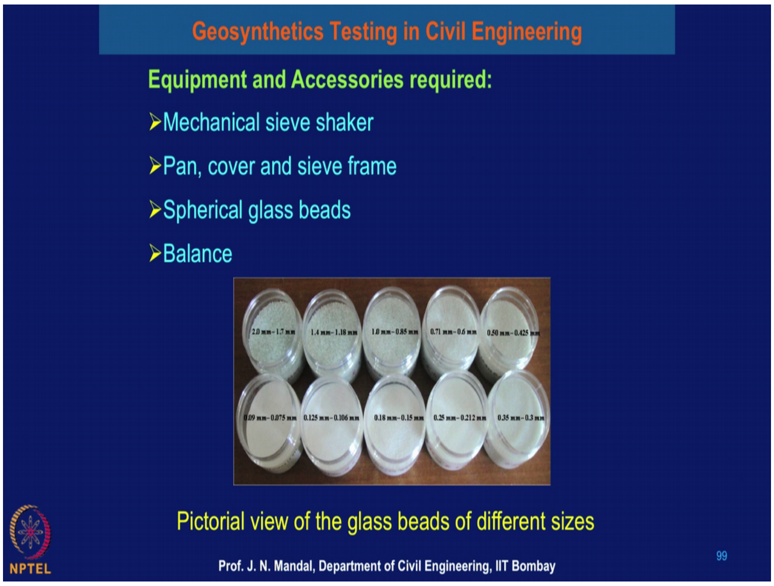

Equipment and the accessory that required, that is mechanical sieve shaker and then pan cover and the sieve frame and spherical glass beads and the balance. So, these are the pictorial view of the glass bead of different different sizes.

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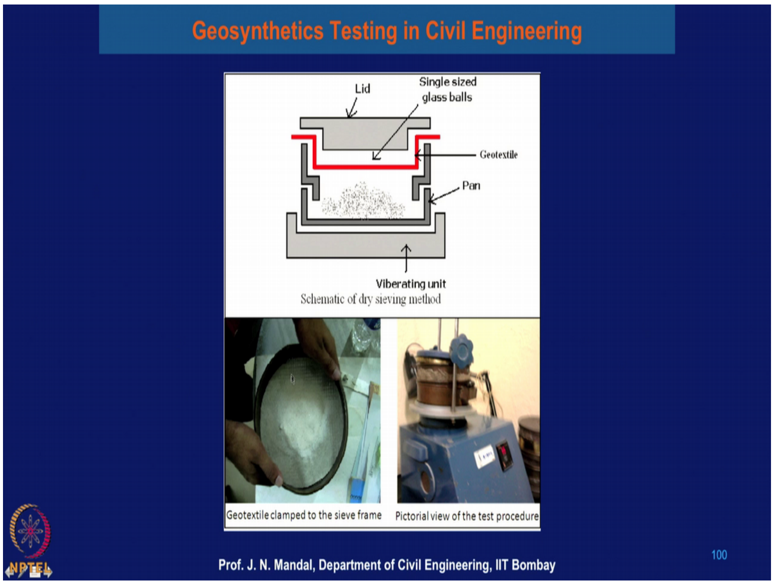

You can see here, this is the this is the bead and this is the your vibration unit, this is a schematic of dry sieving method and this is the pen, and this is the geotextile material, which is titan with this with the sieve and this is the lid and this is single size of this is the single size of the this is the single size of the class bead. So, geotextile is cramp at the sieve and then bead sieve on the top and you can see in this machine and you can determine that, what should be the apparent opening size?

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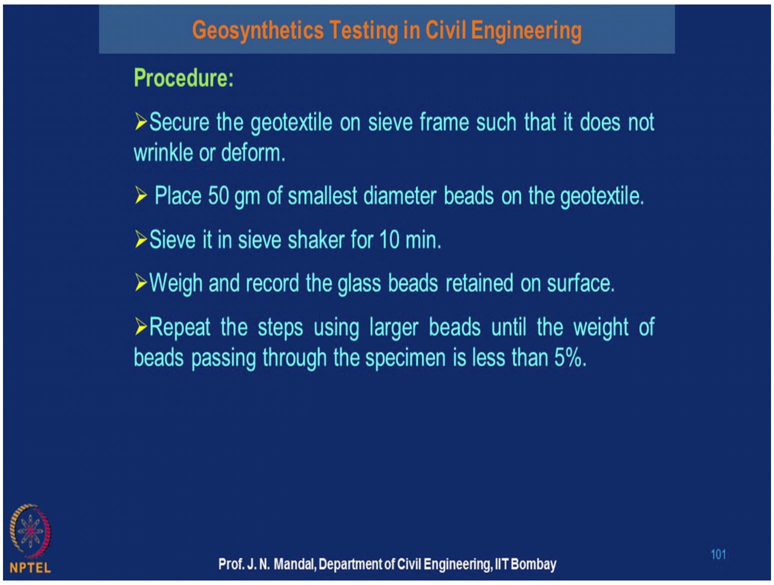

So, for these procedures secure the geotextile on the sieve frame such that it does not wrinkle or deform place 50 grams of the smaller diameter beads on the geotextile. And sieve it in sieve shaker for 10 minutes, weigh and record the glass beads retained on the surface repeat the steps using the larger bead, until the weight of the bead passing through the specimen is less than 5 percentage. So, that you have to remember 5 percentage passing through.

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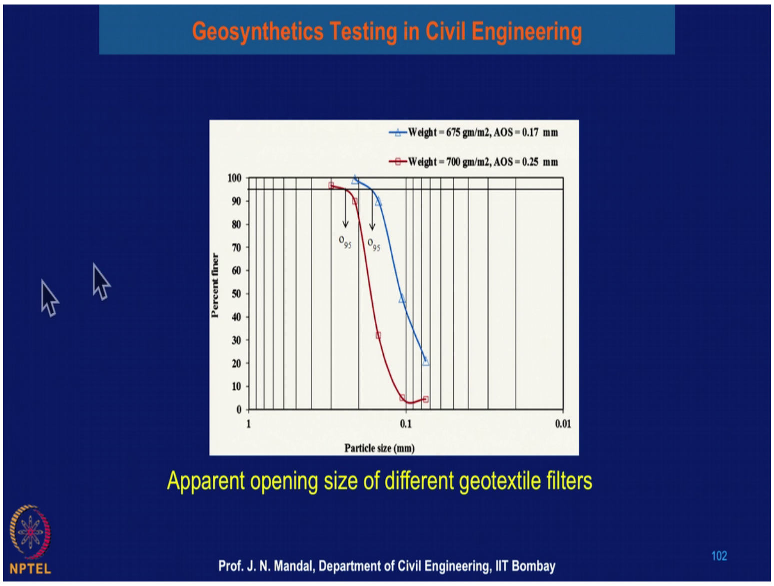

And, then you can draw the relationship between the percentage finer and the particle size and it depend on the, what should be the weight this 675 gram per meter square. And then for this O 95 is very important. So, you can determine what is O 95? So, this gain size distribution curve is vary from material to material.

So, you can see one is the 675 gram per meter square weight another is the weight of the sample is 700 gram per meter square. So, for this you can determine what is O 95 for the red one O 95 for the blue one. And, this AOS for W 1 is 8.17 millimeter and for AOS for the 700 gram per meter square is 0.25 meter square.

So, this value is very important that what should be the apparent opening size of the geosynthetics material? They have to design that, what material should retain on the geosynthetics material? And what material should pass it through the geosynthetics material? So, this is used mainly for the filtration and drainage system and apparent opening size is very very important for also the any kind of the water flow related problem eurocent control related problem.

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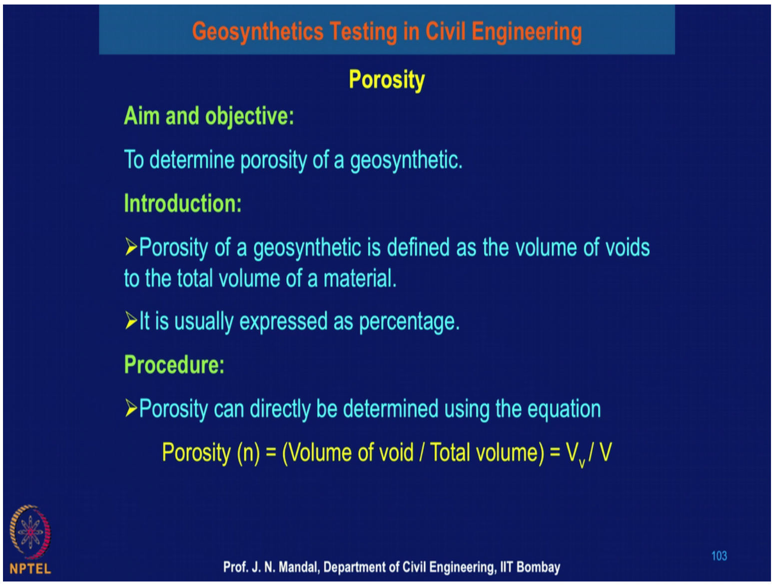

Next I will talk about the porosity main objective to determine the porosity of a geosynthetics material. And porosity of a geosynthetic is defined as the volume of the voids to the total volume of the material. It is usually expressed as percentage. And the procedure is as porosity can directly be determined using the equation, you know that porosity n is equal to volume of void divided by total volume, that is V of v divided by V.

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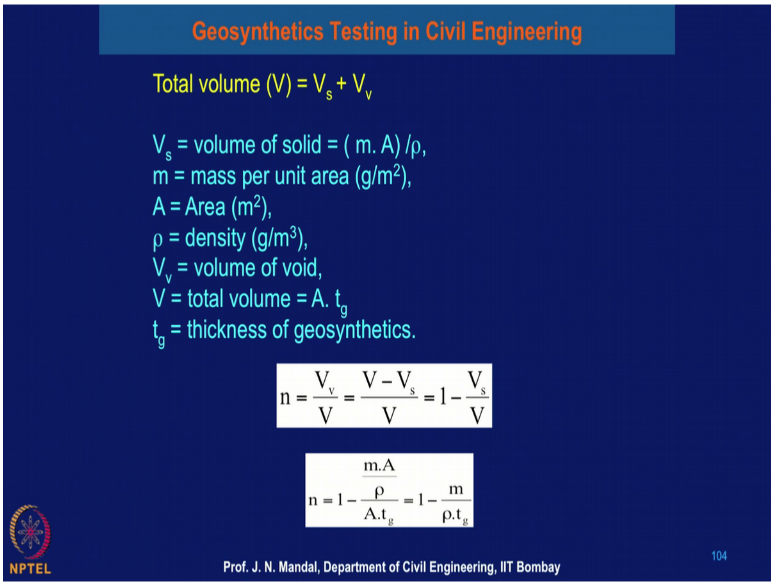

So, you can determine that if the total volume V is equal to V s plus V of v.

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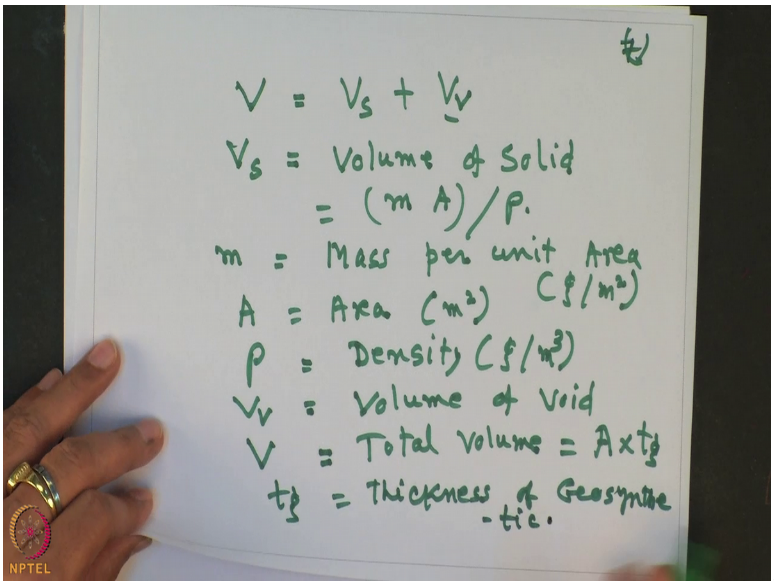

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So, V s is the volume of solid volume of solid. So, this is equal to m into A this divided by rho, where m is equal to mass per unit area, that is gram per meter square. And, A you know that is area and that is in meter square and rho is the density. So, that is gram per meter cube.

And, V v V v is the volume of void V v is the volume of void. And so, total V will be the that mean this is total volume. So, total volume is equal to A into t of g, where t g is the thickness of geosynthetics thickness of geosynthetics. So, from this you can calculate that, what should be the porosity of the geosynthetics material?

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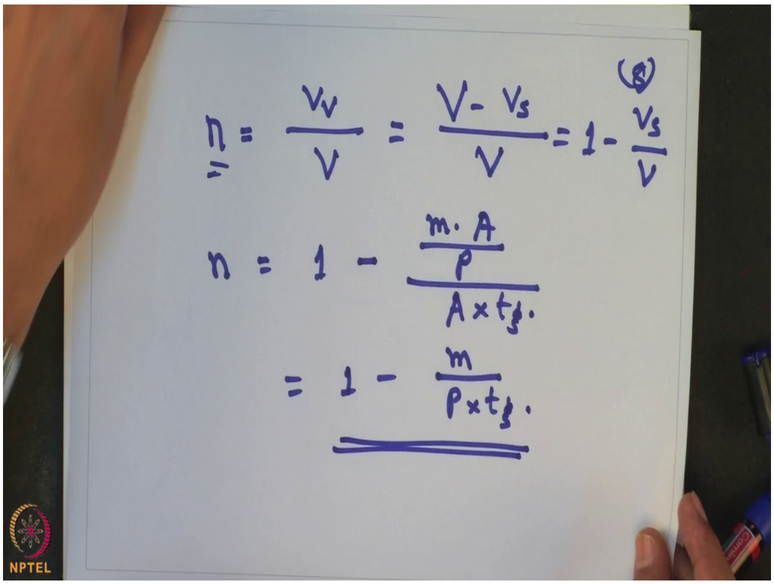

So, n porosity this is volume of void divided by V is equal to V minus V of s divided by V; that means, this equal to 1 minus V s divided by V. So, again n is equal to 1 minus this we can write m into A divided by rho, this divided by this volume is equal to A into t of g the thickness of the geosynthetics material.

That means, this you can write 1 minus m divided by rho into t into g. So, you can determine what should be the porosity of the geosynthetics material? So, you have to remember this equation 1 minus m into rho into g. I can give 1 specimen calculation for the determination of the porosity of the material. So, for the specimen calculation so, you know that let us say it is a non-woven geosynthetics material and mass per unit area unit area is equal to 258 gram per meter square.

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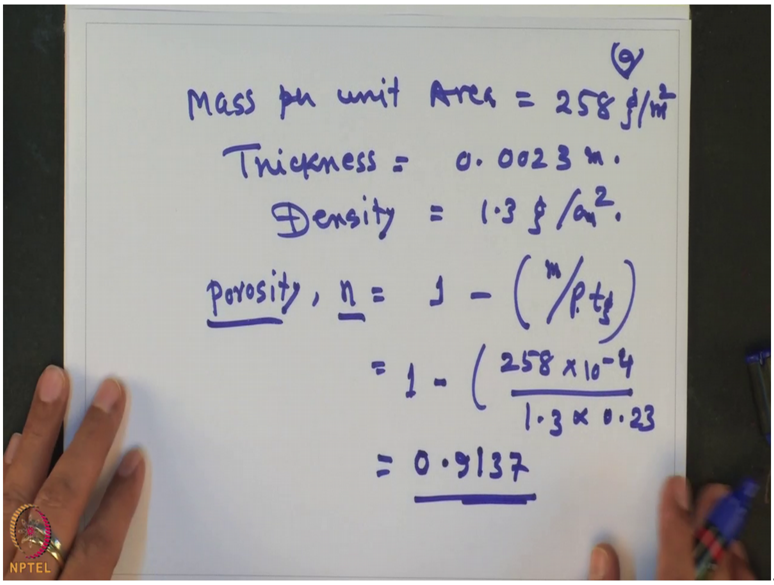

And, let us say thickness of the geosynthetics material is 0.0023 meter. Now, you know the density is equal to 1.3 gram per centimeter square. So, porosity n is equal to 1 minus m divided by rho into t of g. So, you know this equation. So, you can write 1 minus m is equal to 258 here mass per unit 258 into 10 to the power minus 4 this divided by 1.3 is the density rho this into thickness of the geosynthetics is 0.23. So, you can determine that what should be the porosity? So, n value will be 0.9137. So, this way we can calculate that, what should be the, what should be the porosity?

And next is the: endurance properties of the geosynthetics material, that what is called the abrasion and ultraviolet degradation and clogging, what is called the gradient? And clogging is very important because you have to check whether the geotextile material has been clogged or not.

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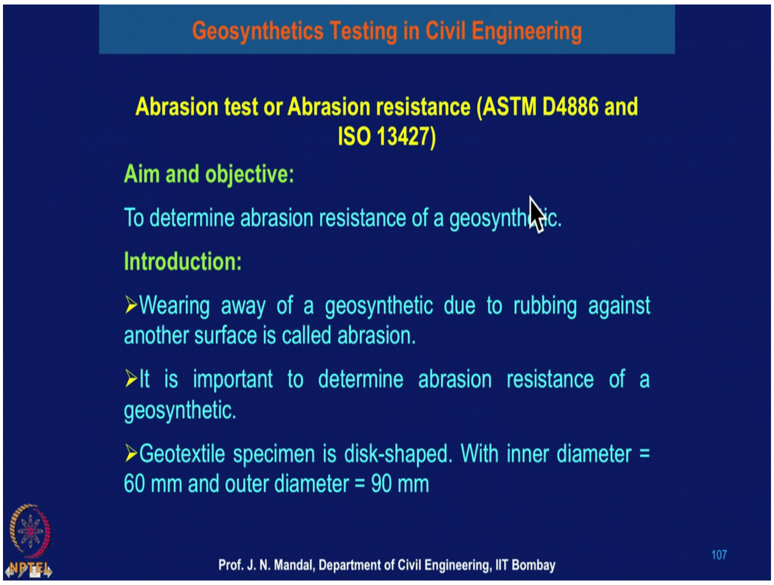

So, abrasion test or abrasion resistance as for the ASTM D 4886 and ISO 13427 so, main objective of these two determine the abrasion resistance of a geosynthetics material. So, wearing away of the geosynthetic due to rubbing against the, another surface is called the abrasion. Because, geosynthetics material may be damaged when you can use for the railway construction, on the rail can passes. And you are using the geosynthetics material for the construction of the railway infrastructure.

So, there should be a load when you will passing through this material, then geosynthetics material there will be the rubbing. So, there will be the abrasion between the geosynthetics material and the granular material. So, that is why it is required that what should be the abrasion? You know that the geosynthetic material should not be clear of. So, it is determined that abrasion resistance of a geosynthetics material. So, geosynthetics specimen you have to keep in a disk shape with a inner diameter about 60 millimeter and the outer diameter about 90 millimeter.

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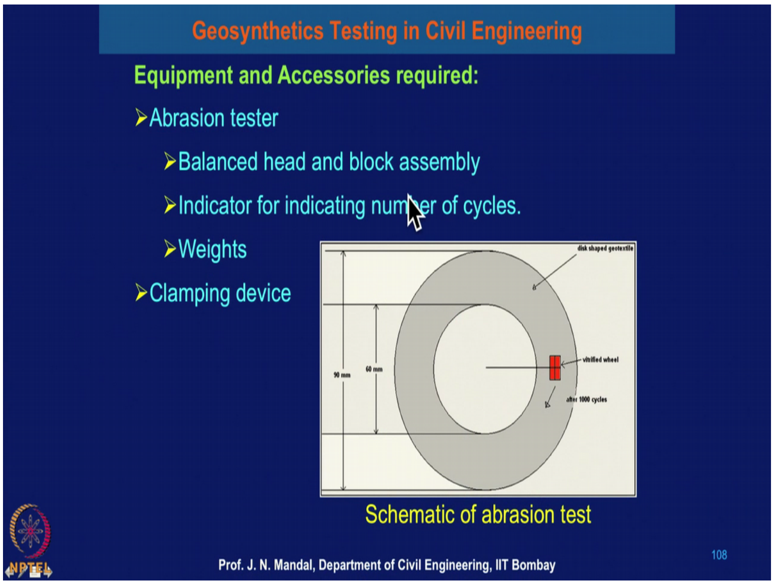

So, you can see here that you can see here the equipment and the accessory for abrasion test this is the balance head and the block assembly indicator for indicating number of the cycle weight and camping device. So, this is the schematic abrasion resistance geosynthetic material is placed and then this geosynthetics material (Refer Time: 26:33) and then it is rotate and geosynthetic material may be clear it up.

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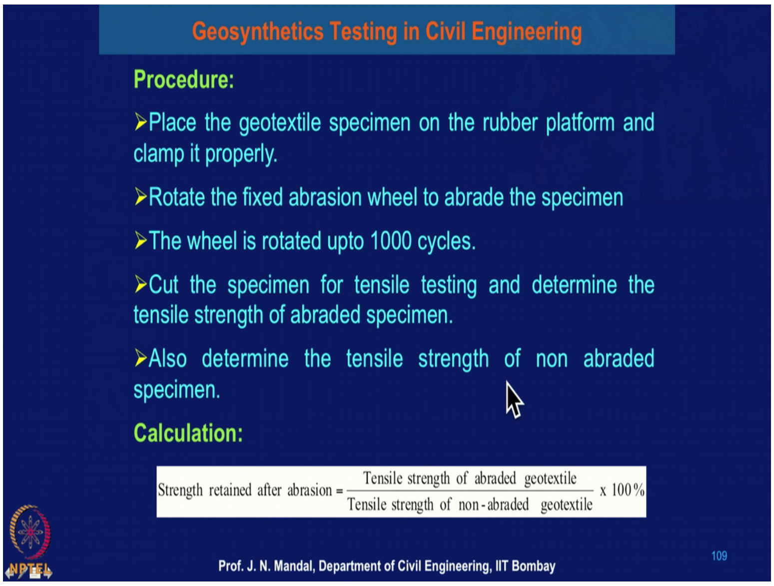

So, procedure for this is that, place the geotextile specimen on the rubber platform and clamp it properly. And, the rotate the fixed rotate the fixed abrasion wheel to abrade the specimen. The wheel is rotated up to a thousand cycle and cut the specimen and to determine, what will be the tensile testing of the geosynthetics material due to abraded specimen?

Also you determine what will be the tensile strength of the geosynthetis, without abraded. Then you take the ratio of the tensile strength of the abraded specimen and the tensile strength of non-abraded specimen. And, that into 100 which will give you the abrasion resistance of the geosynthetics material.

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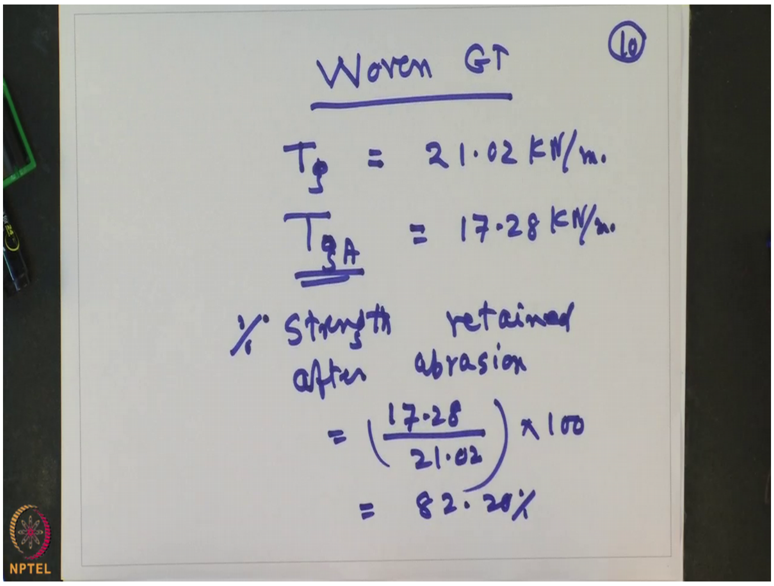

For an example that specimen calculation, suppose type of geosynthetics is the woven woven geotextile material and tensile strength of the non-abraded geosynthetics material. That means, tensile strength of non-abraded geosynthetic material is 21.02 kilo Newton per meter. And tensile strength of the abraded geosynthetic material let us say 17.28 kilo Newton per meter.

So, you have to determine what will be the percentage of the strength retained percentage of the strength retained after abrasion. So, this is 17.28 divided by 21.02 this into 100. So, this will give 82.20 percentage. So, abrasion resistance is very important for the determination of the geosynthetics material. So, that geosynthetics material should not be any damage.

So, we check up all these different types of permittivity transmittivity test, we talk about what the apparent opening size of the geosynthetics material, we talk about the porosity of the geosynthetic material, we talk about the abrasion resistance of the geosynthetic material. So, this is very important abrasion resistance. So, that geosynthetic material should not be damaged. So, this test is very important.