Geosynthetics Testing Laboratory
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Lecture – 13
Sewn Seam Strength, Permittivity and Transmittivity

I am Professor J. N. Mandal Department of Civil Engineering IIT Bombay. I will teach you today about the Sewn Seam Strength of the Geotextile Material, because sometimes you required to connect one geotextile with the another geotextile you require sometimes teaching, you require sometime seaming, you require sometime (Refer Time: 00:44) of the Geosynthetics material.

So, this is very important, because this is the joining between the two different types of the either woven or non-woven geotextile or it may be the geogrid material. Therefore, one should know the sewn seam strength of geotextile. Now, seam strength of geotextile this as for as for the specification ASTM D 4884 and International Standard Organization ISO 13426.

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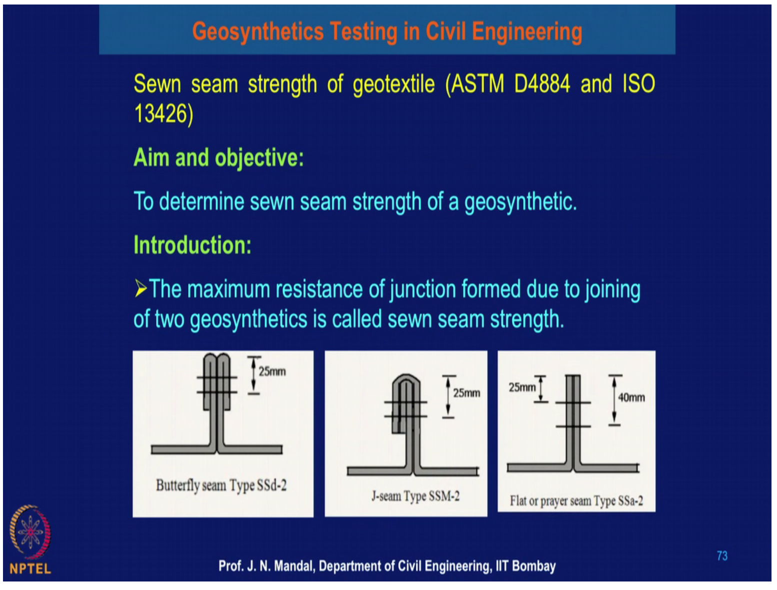

The main objective of this test: to determine the sewn seam strength of the geosynthetics material. So, maximum resistance of the junction formed due to the joining of two geosynthetics is called the sewn seam strength. We can see here different types of the difference types of the joining system and this is the butterfly seam type that is SSd-2.

And it is like one geosynthetics material here, another geosynthetic material here, and then you are teaching the spacing of 25 millimeter and this is called butterfly seam. This is another kind of the joining, which you call J Type of seaming. So, this is J-seam type SSM-2 and this spacing between the 2 joining is about 25 millimeter. And, this is another type of joining, which is called flat or prayer seam type of this is SS a-2 so, here also this 25 and 45 millimeter. So, when I will recommend that butterfly of the system is recommended for the joining.

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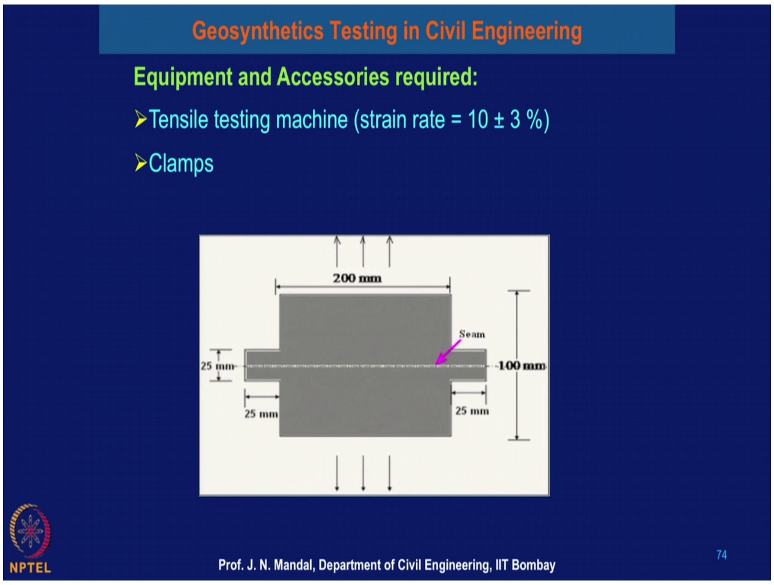

Now, this test is performed the same that in universal testing machine and strain rate about 10 to 3 percent, it is the same as we perform the tensile strength of the geosynthetic material and clamp arrangement is the same. The slightly defines in the sample size as you know, in case of tensile strength of the geosynthetics the size is about 100 millimeter by the 200 millimeter, but in this case these two geosynthetic material is teaching here. So, it is seaming here it is. So, it is about 25 millimeter and 25 millimeter projected and this is the teaching, and then you perform the tensile strength of the geosynthetics material.

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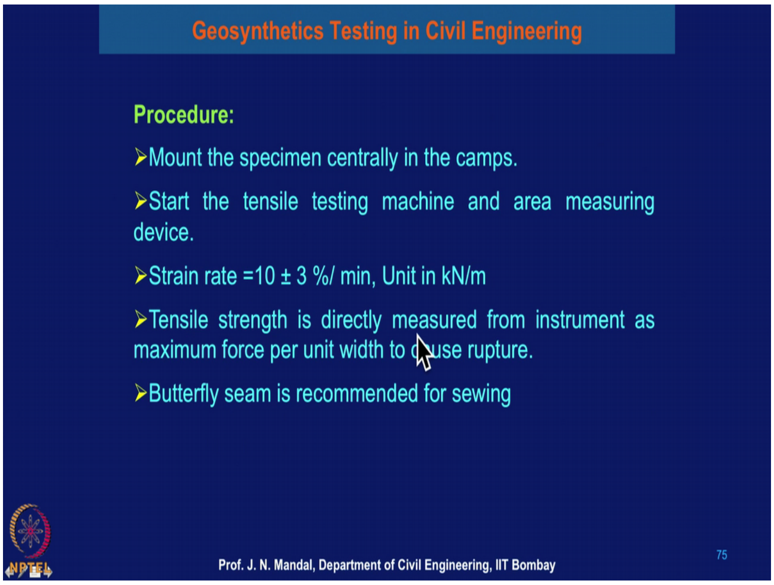

So, procedure mount the specimen centrally in the camp start the tensile testing machine and the area measuring device. And, as I said the strain rate is 10 plus minus 3 percentage per minute and the unit of the seam strength is in terms of the kilo Newton per meter. So, tensile strength is directly measured from the instrument, as maximum force per unit with to cause the rapture. It also told that butterfly seam is recommended for the same.

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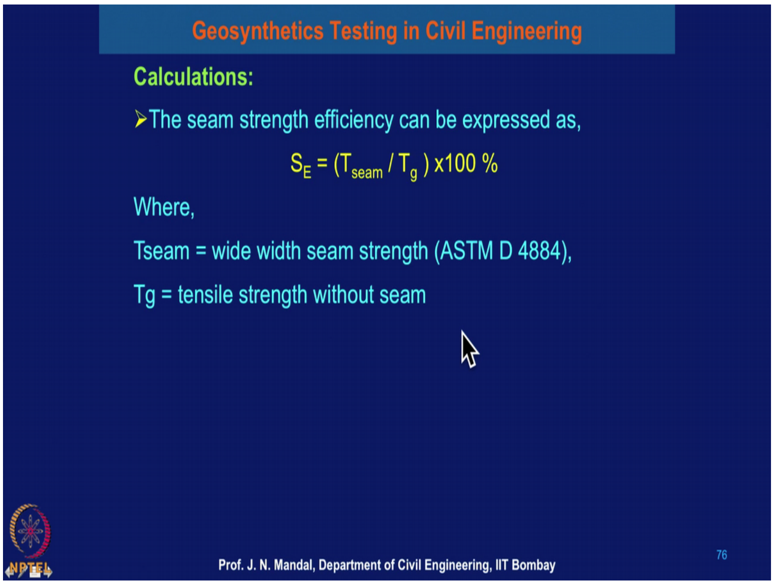

So, how to calculate the seam strength? So, seam strength can be calculated and seam strength efficiency can be expressed as S E is equal T seam divided by T g into 100 where T seam is the wide width seam strength as for ASTM D 4884.

And, T g is called tensile strength without change. So, one is without strain, another is with strain. So, you take the ratio of T seam and the T g into 100 and which will give you what will be the efficiency of the geosynthetics material? And, this seam strength we have to take into consideration into the design.

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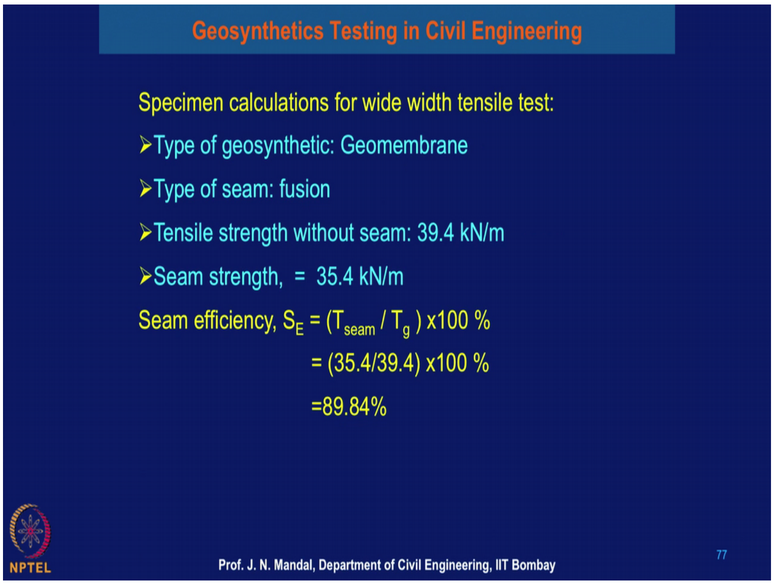

Now, specimen calculation for the wide width tensile strength let us test type of the material it may be geosynthetics or the geomembrane material. And type of the second sewn seam is may be the fusion, or tensile strength without seam is 39.4 kilo Newton per meter and which seam strength is 35.4 kilo Newton per meter.

So, you can determine what is the seam efficiency? So, seam efficiency S E is equal to T seam divided by T g into 100; that means, 35.4 divided by 39.4 into 100. So, this efficiency is 89.8 4 percentage. So, this one should understand that, what will be the seam strength of the geosynthetics, because this is one of the weakest point of the geosynthetics material.

And, that you have to consider into the design otherwise sometimes that infrastructure or any kind of the design, there will be a possibility for the failure of the geosynthetics material.

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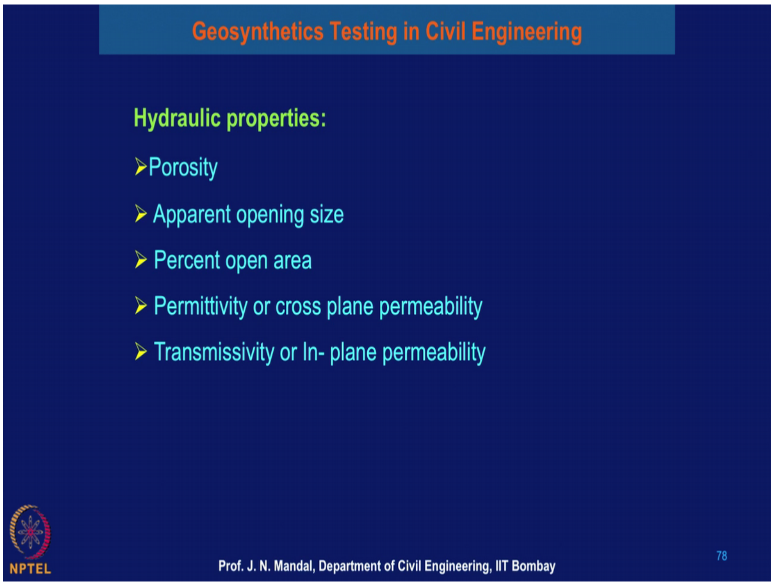

Next, I will discuss the hydraulic property. So, so far what we have discussed this is all strength provided problem? What we use the geosynthetics material for the design of the of the reinforce soil retaining wall or the slope related problem or payment related problem. Now, we will discuss the another property. So, it is hydraulics property. It is very important and hydraulic property is related with the flow related problem.

It maybe flow of liquid or water or the gas. So, this is also very important, it should be related with also the drainage and also the filtration system. So, this hydraulic property, we have to determine what will be the porosity of the geosynthetic? What will be the apparent opening size or the equivalent opening size of the geosynthetic material, percentage open area and the permittivity of the geosynthetic material and transmittivity of the geosynthetics materials?

These are the two parameter is very important particular is the permittivity and transmittivity and also the equally important that, what will be the apparent opening size or equivalent opening size of the geosynthetics material. So, I will just proceed one by one how you will perform all the kind of the testing that is.

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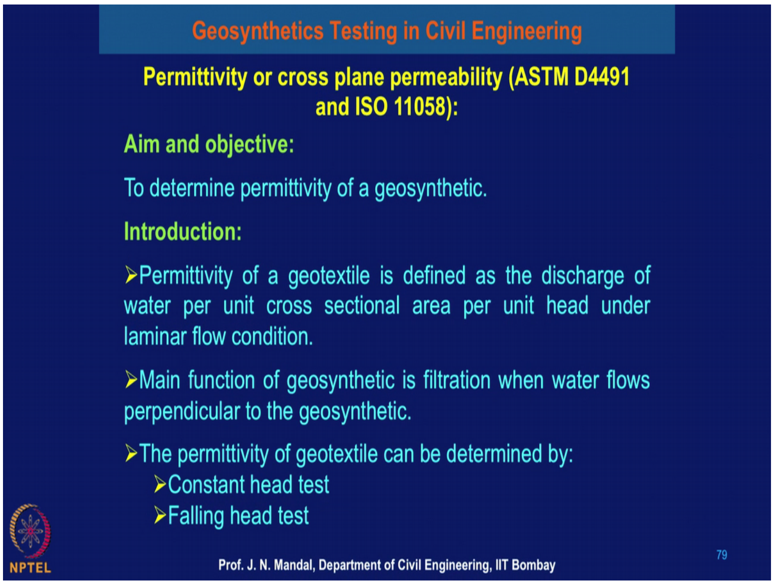

First that permittivity of cross plane permeability and this test is perform as for ASTM D 4491 and ISO 11058, the main objective of this test to determine the permittivity of a geosynthetics material. Now, what do you mean by the permittivity? So, permittivity of the geosynthetics is define the discharge of the water per unit cross section area per unit head under the laminar flow condition. And, main function of the geosynthetics is the filtration, when the water flow perpendicular to the geosynthetics material not across the geosynthetics material.

So, you remember that when you talk about the permittivity then water flowing across the plane of the geosynthetics material. So, that what you call the permittivity. And, you have to determine whether it is a permittivity or the transmittivity, whether it is a filtration or the drainage you have to decide, when you have to apply accordingly to your particular problem or particular application. Now, this test is performed with the constant head test or the falling head test method. So, I will show you what is the constant head method and the falling head test method?

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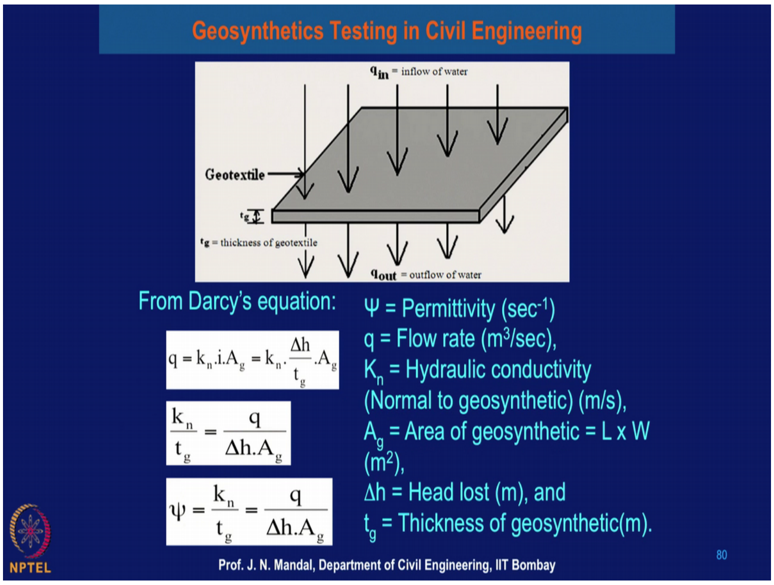

So, here you can see that this is the geosynthetics material and the water is flowing from the top to the bottom this is q in and this is q out, and this is the geotextile material, and this geotextile material has a thickness that is t of t of g. And, this is the thickness of geosynthetic material and water is flowing across the plane of the geosynthetics. So, you know that from the permittivity of the geosynthetic material from the Darcy's equation, we can I can write that from that Darcy's equation that is you know q is equal to k into n into i into A into g.

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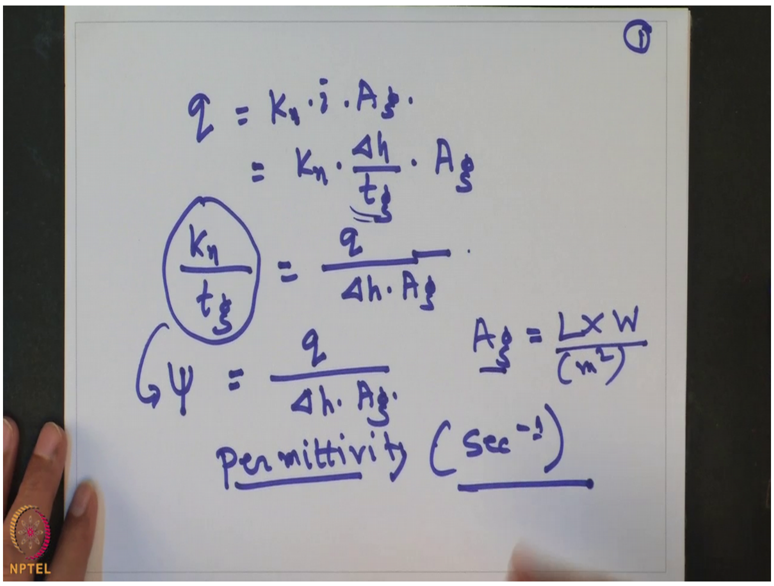

So, this again is equal to k into n i is equal to delta of h and t g is the thickness of the geosynthetics material and A is equal to area of geosynthetics. So, you can write k of n divided by t of g is equal to q divided by delta h into A of g. So, this is the psi psi the permittivity. So, this you can say this part is the psi psi, which is permittivity will be equal to q divided by delta of h into A of g. So, psi which you call the permittivity and this unit is per second, remember this units of permittivity is per second ok.

q is the 4 8 is meter cube per second and k n is the hydraulic conductivity, that is the normal to the geosynthetics, that is unit is meter per second and the delta h is equal to head loss and t g is the thickness of geosynthetics material and A of g. The A of g is area of geosynthetics material, which you can say that L into W that is m meter square. So, do you know what will be the length of the geosynthetic material? And, what will be the width of the geosynthetic material?

So, knowing this value of quantity of flow water percentage geosynthetic I and the head loss and the area of the geosynthetics that is length into the width so, you can determine: what is the permittivity. And, permittivity unit of permittivity can be expressed as meter per second per second only.

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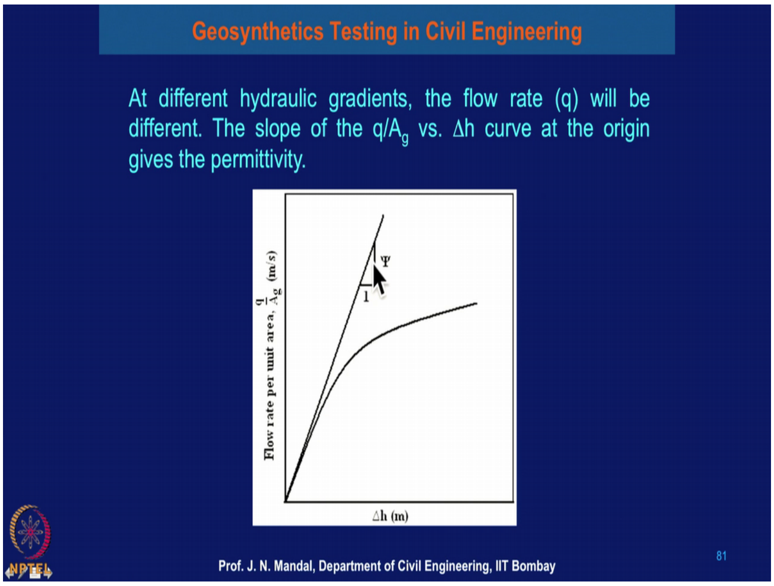

Now, this another also kind of the different hydraulic gradient, you can write that different hydraulic gradient of the hydraulic gradient the flow rate of q will be the different; the slope of the q by A g, but says this is slope this is a slope of q by this is the this is the slope different hydraulic gradient you are taking.

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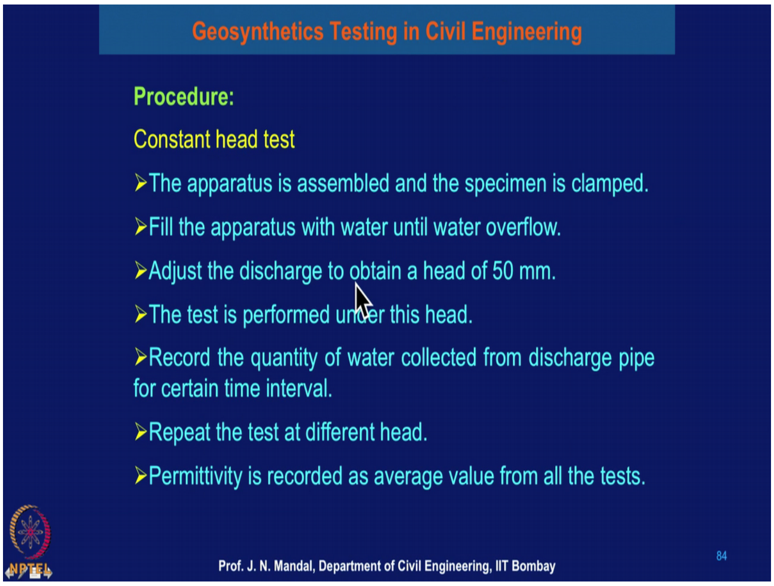

And, this is the this is the different hydraulic gradient of flow rate that is q will be the different types the slope of q by A of g versus delta of h curve, at the origin which will give you that what will be the permittivity of the geosynthetics material?

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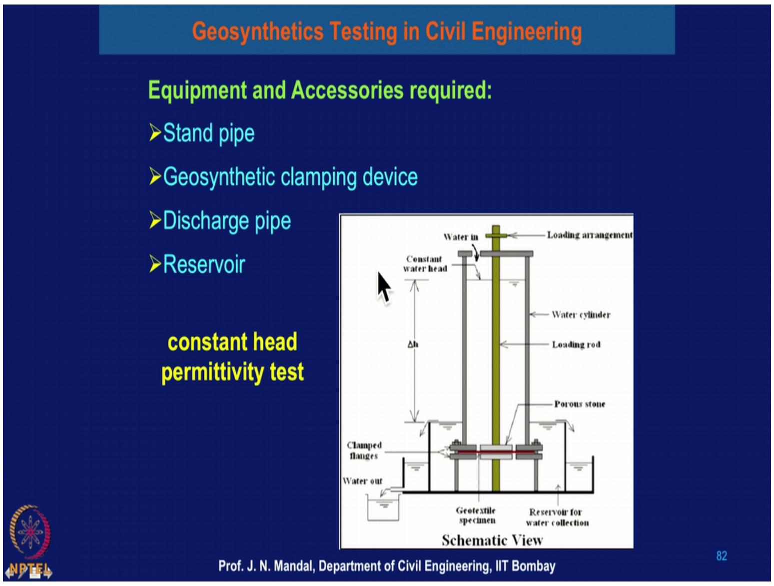

Now, what are the equipment you required for the determination of constant head permeability test of the geosynthetics material. So, you required that what is the stand pipe? And geosynthetics is clamped geosynthetics is clamped here and the device and discharge pipe and then it is the reservoir. So, water can flow from top to the bottom at a constant head of permittivity. And, then you are collecting the water here in the reservoir.

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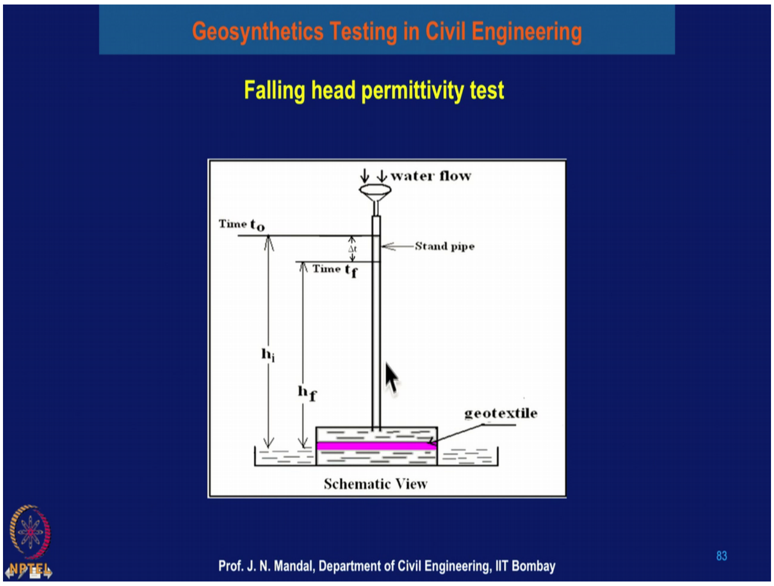

So, after collecting the reservoir, it is another kind of falling head permeability test method this is a geosynthetics material is here. And, this distance is the initial time initial time t 0, when the height is initial h i. And when the, this is the time after a certain time this time is t of f final time. So, then this is the h of f height, which is measuring from here to here and geotextile material is here. So, this is the stand pipe. So, form this test. So, you can determine that what will be the permittivity of the geosynthetics material?

Now, this procedure for constant head test the apparatus is assemble and specimen is clamped fill the apparatus with water until water overflow. Adjust the discharge to obtain the, to obtain a head of about 50 millimeter. So, the test is performed under this head and records the quantity of water collected from the discharge pipe for a certain time interval and repeat the test as different head, so permittivity is recorded as the average value from all the test.

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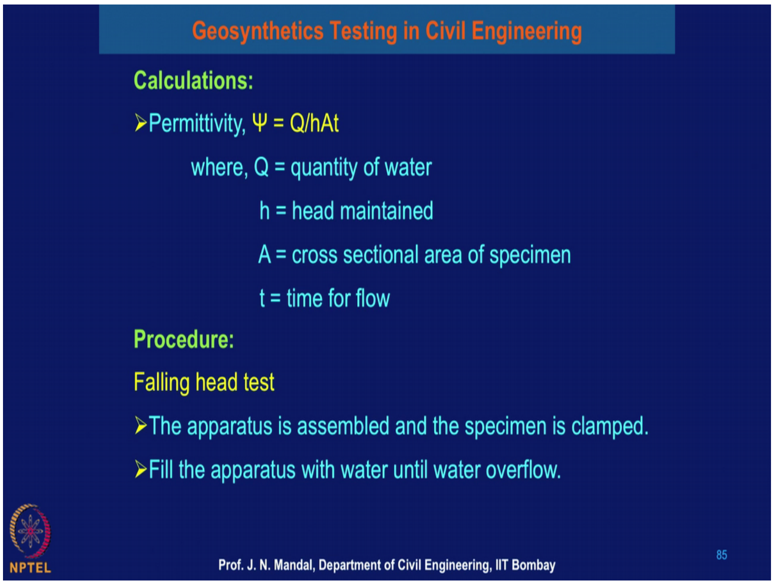

So, we can calculate the permittivity you know the equation psi is equal to Q by h into A t. So, where Q is equal to quantity of water, h is equal to head maintained, A is equal to cross selection area of the specimen and t is the time of flow. So, another so, knowing this value what will be quantity of water you have collected at a particular time.

So, what will be the height? You know what a head? And, you know the cross sectional area of the geosynthetic material. So, you can determine the permittivity using this equation. Now, another procedure is the falling head test method. This apparatus is assemble and the specimen is clamped and fill the apparatus with water until the water overflow.

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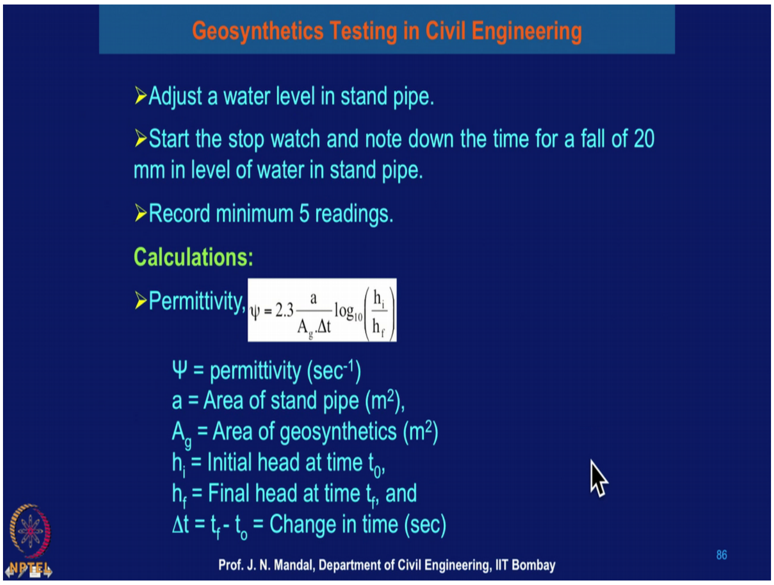

So, adjust a water level in the stand pipe and then we can start the stopwatch and note the time for a fall of about 20 millimeter in the level of the water in the stand pipe. So, we record the minimum 5 reading.

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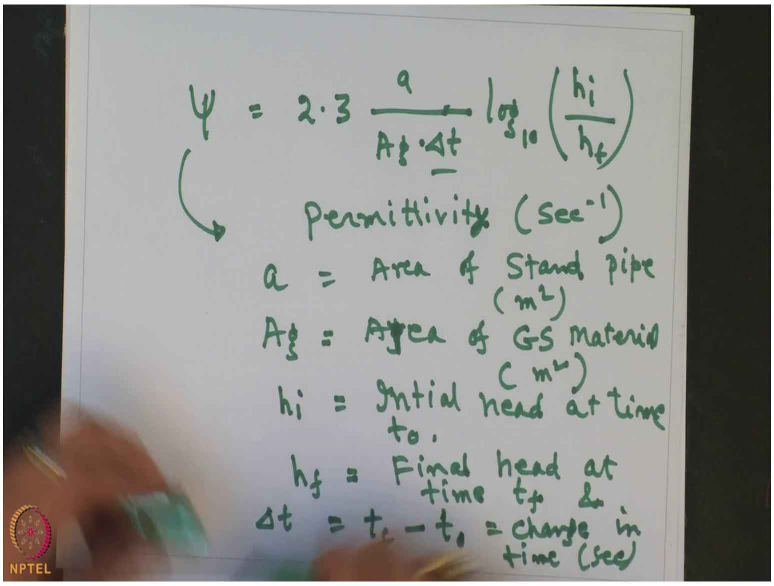

So, you can use this equation that is equal to psi which you call the permittivity. So, equation you know psi is equal to 2.3 into a divided by A of g into delta of t into log of 10 h of i by h of f. So, you know this i pi, which you call the permittivity. And the unit is per second per seconds. And a small a is equal to area of stand pipe, you know area of that is stand pipe that is let us say meter square. And A g is you know area of geosynthetics material area of geosynthetics material. And, this is in meter square and h i is equal to initial head initial head at time t 0 and h of f is equal to final head at time t of f.

And, delta of t delta of t is equal to that is t of that h of at a particular t of f and t of 0 that is change in time change in time and that it is which unit is second. So, knowing this all these value you know cross sectional area of the stand pipe, you know what will be the h on value and the h f value and you know the, what will be the delta of t value, you know what will be the area of the geosynthetics material? So, you can calculate the permittivity of the geosynthetics material.

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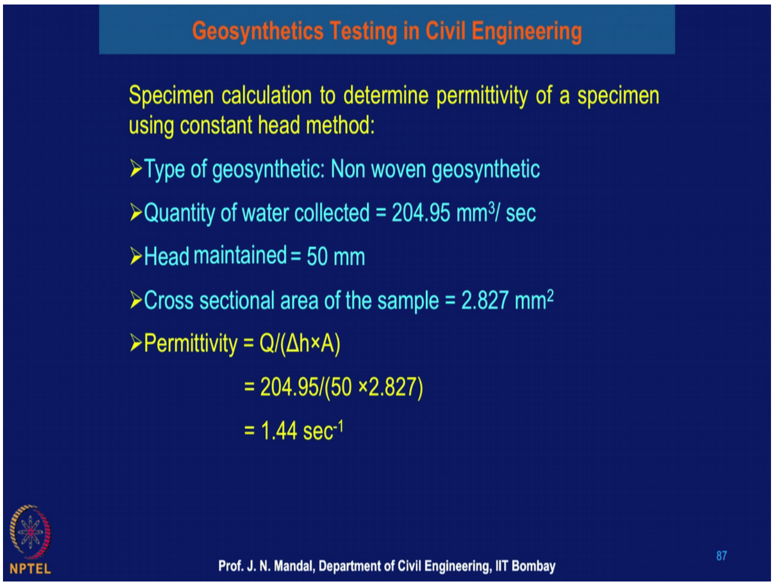

So, specimen calculation for the to determine the permittivity of a specimen. For example, you are taking that type of geosynthetics is the non-woven geosynthetics material and quantity of water collected about 204.95 millimeter cube per second. And, the head maintenance about 50 millimeter and cross section area of the sample is given 2.827 millimeter square. So, you know the equation permittivity is equal to Q by delta h into A. So, Q is the quantity of water collected that is 204.95.

This divided by that is delta of h; that means, head measurement is 50 and this into this is cross sectional area of the sample this is 2.827. So, if you can calculate. So, you can obtain the permittivity which is 1.44 per second. So, this is what we call the permittivity of the geosynthetics material? The permittivity of the geosynthetics material is very important and particularly in case of the drainage and the filtration problem. And you remember permittivity, then when the water or gas pass across the plane of the geosynthetics material and the unit of permittivity is per second. Now, we will discuss about the transmittivity of the geosynthetics material. Now, transmittivity it is a in plane, then when the water or liquid or gas pass along the plane of the geosynthetics material is called the transmittivity.

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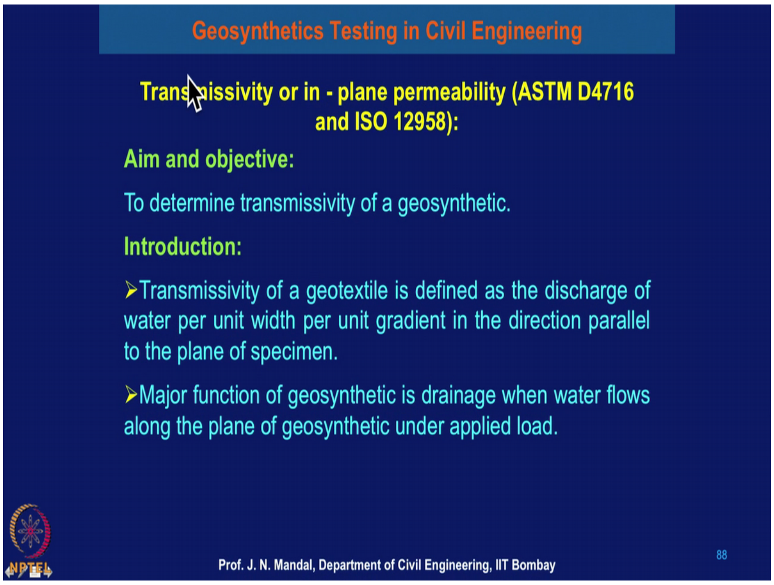

So, this transmittivity can be can be can be done by the ASTM D 4716 and ISO 12958. So, main objective of this test to determine transmittivity of a geosynthetics material, to transmittivity of the geotextile is defined as the discharge of water per unit width per unit gradient in the direction of parallel to the plane of the specimen. So, manual function of the geosynthetics is the drainage when the water flow along the plane of the geosynthetics material. So you remember between the define between the two, one is the relation another is the drainage.

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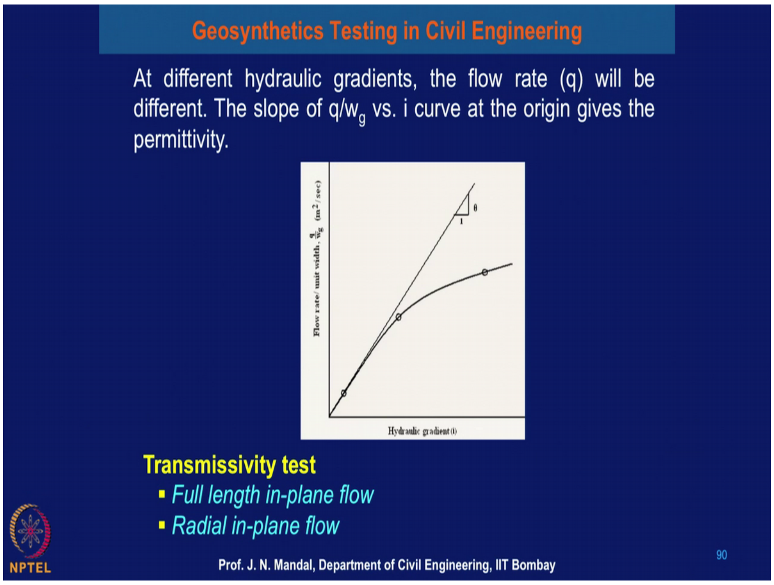

In case of the permittivity, it is a filtration and in case of the trasmittivity it is a drainage; that means, when the water flow along the plane of the geosynthetics material.

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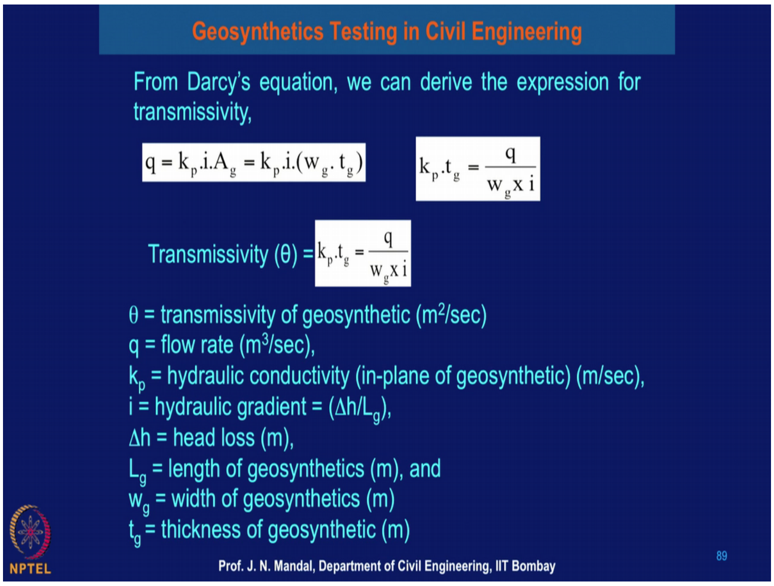

So, how to that calculate that transmittivity?

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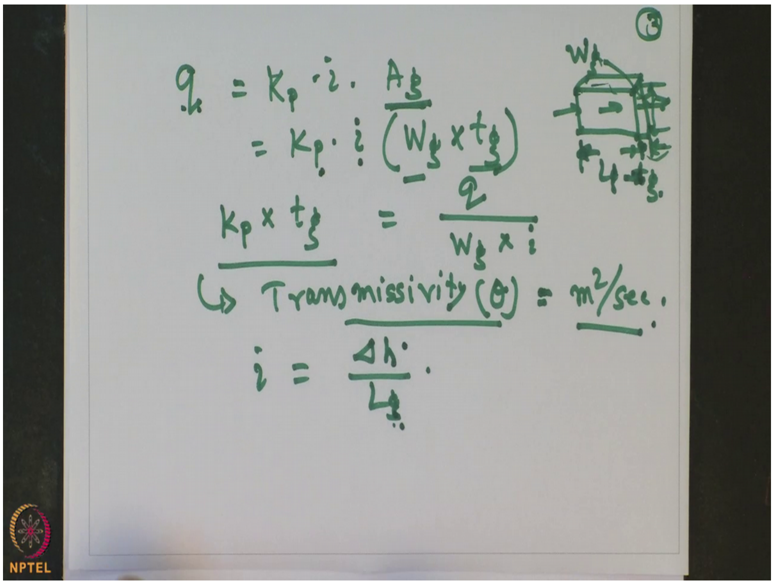

So, from the Darcy's equation you know q is equal to k of p into i into A of g. So, this is k of p into i into here area is equal to W of g into t of g. So, we can write k p into t of g is equal to q divided by W of g this into i or k p by t g which you call the transmissivity. And, this is express as theta and this is transmittivity, this unit is meter square per second. So, here because water is flowing along the plane of the geosynthetics material that is why this if the geosynthetics material is like this and water is flowing along the plane of the geosynthetics material.

So, this geosynthetics material has a certain thickness that is t of g and this width is equal to this W g width of the (Refer Time: 25:18) that is why this area because this is flowing along the plane of geosynthetics material. So, that area of geosynthetics will be W g into t of g. So, when you know that theta transmittivity of the geosynthetics material, the unit is meter square per meter square meter square per second and q is the product that is meter cube per second, and k p is the hydraulic conductivity in plane of the geosynthetics material. And i is equal to hydraulic gradient that i is equal to hydraulic gradient is equal to delta h by L of g and delta h is the what you call head loss?

And, L g you know length of the geosynthetics material, if this is the length of the geosynthetics material here. And W g is the width of the geosynthetic material and t g is the thickness. So, you know all this value. So, you can determine what will be the hydraulic conductivity or the transmittivity of the geosynthetics material? Now from this you can different types of the hydraulic gradient you can take and the flow rate q will be the different slope of the q by W g verses the i curve at the origin give the permittivity. So, there are different types of the test one is the full length in plane flow, another is radial in plane flow.

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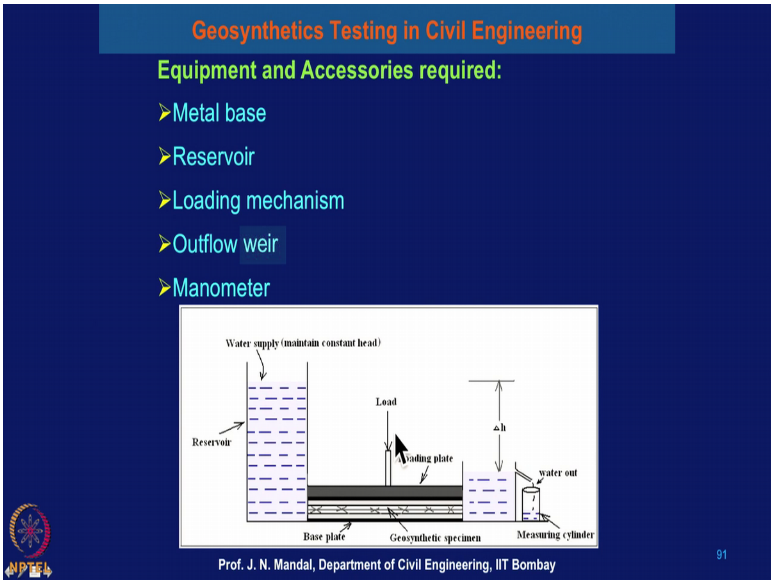

So, full length in plane flow is required the accessories that what will be the metal base; what will be the reservoir? What will be the loading mechanism? And outflow weir and the manometer. So, here you can you can see that this is the equipment and this is the geosynthetics material, which is located between the 2 solid plate and the water reservoir is here water is flowing across the plane of the geosynthetics material and you are collecting the water here in a in a in a container.

And, then you will be knowing what is the quantity of water passes along the plane of the geosynthetics material and collect it into this water (Refer Time: 27:57). And, at a particular time what will be the volume of water collected here. And they defines in the head is equal to delta of h. So, this is you have to perform the test under different loading, it may be the 50 kilonewton 250 100 kilonewton 250 kiklonewton or the 300 or 350 kilonewton or 400 or 500 600 700 800. And, then you can correlate between the what should be the quantity of water pluses and what should be the load?

So, you can draw a correlationship between the quantity of water flow and then what should be the applied load? So, you know each and every time what will be the quantity of water flow and what will be the under water pressure? So, you can make a correlation between the between the applied load and corresponding the quantity of water, you can have a nature of that curve the quantity of flow is load is increasing the your quantity of water flow is decreasing. So, this is very important when you will use that PPD or prefabricated particle drain for a particular project, this is very important what quantity of water should flows through the geosynthetics material.

Thank you.