Geosynthetics Testing Laboratory
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Lecture – 07
Puncture Resistance Test

I am Professor J. N. Mandal, Department of Civil Engineering, IIT, Bombay. Now, we will perform the Puncture Resistance Test this as for the specification ASTM D6241 and ISO 12236; main objective of the test to determine the puncture resistance of a geosynthetics material.

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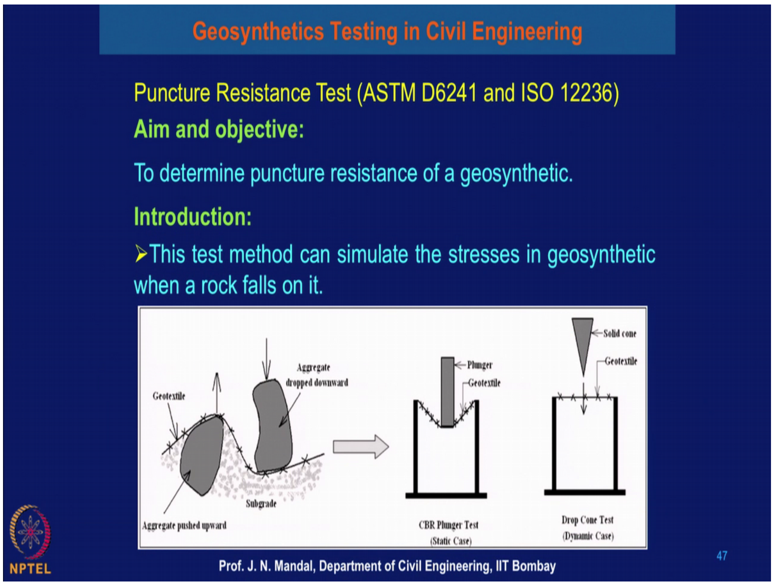

This test method can simulate the stress in the geosynthetics when rock fall on it.

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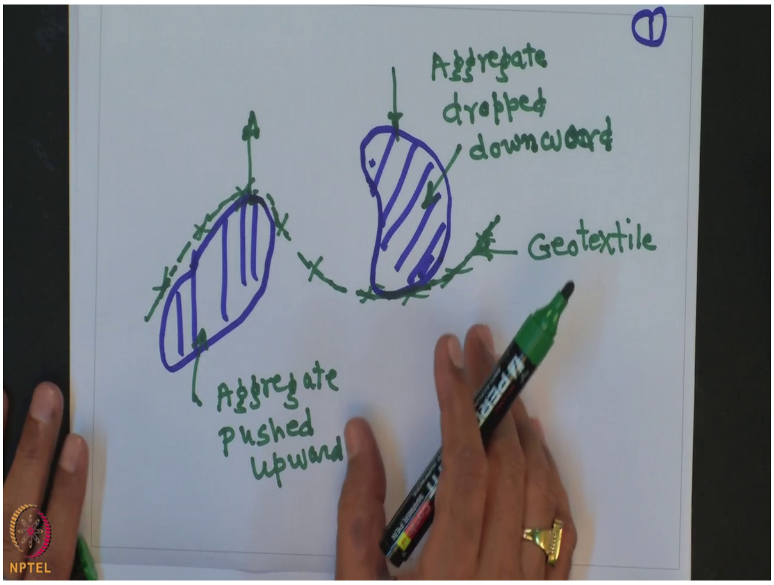

For example that this is the kind of the aggregate or this is another kind of the aggregate material. So, this is the aggregate and this also the aggregate. So, geosynthetics material is like this. This is the geosynthetics material is placed. So, this is geotextile. Now, this aggregate is pushed upward; this is the aggregate, this pushed upward. So, that means, this geotextile material is pushing upward direction.

And, this is the aggregate which is dropped downward. So, this aggregate dropped downward. So, when it is this aggregate is dropped downward this is the aggregate is dropped downward. And this one maybe the angular very sharp kind of the aggregate the other maybe flat type of the aggregate which the aggregate dropped in the downward direction. Now, these two situation can be simulate with the laboratory. Suppose, this is the field situation and this can be simulate with the laboratory test; so one maybe the static test another maybe the dynamic test.

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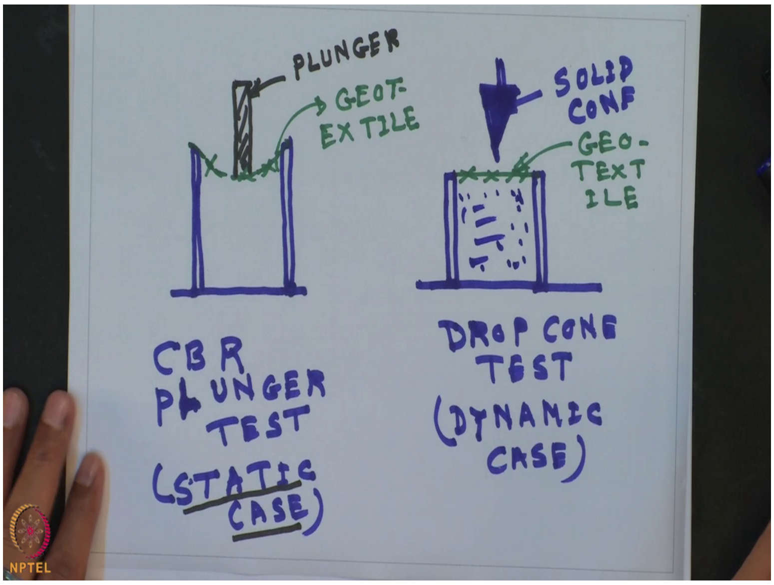

So, this is the CBR plunger test, ok this we call the CBR plunger test or this we can say static case, this is the static case. This is your CBR plunger and geotextile material is clamped here, this is the geotextile material. Geotextile material is clamped in a CBR mold and then you have to plunger a load is applied in the plunger here. So, this I call the plunger, this is plunger. So, you apply the load through the plunger on the geotextile and you can measure what will be the puncture resistance of the geosynthetics material and this is in case of static case.

In dynamic case, what you call the drop contest; so, for example, this is the modified CBR and geotextile material is tightened to the clamp here. So, this is the geotextile and you have to place a plunger solid cone. This is like a solid cone. This is the solid cone solid cone this solid cone is to be dropped from a particular height and it has also the weight. So, this we call the drop cone test and this we call the dynamic case, dynamic case because you are dumping this solid cone at a particular height on the top of the geotextile material and geotextile material will punch. And then you can determine that what will be the diameter of the geotextile material due to the plunging.

And, to simulate the field conditions suppose it is a very soft clay. So, in the laboratory sometime you can use some water here, to simulate the field condition. So, what we discuss severe plunger test that is one in the static case and another is the drop down test which we call the dynamic test.

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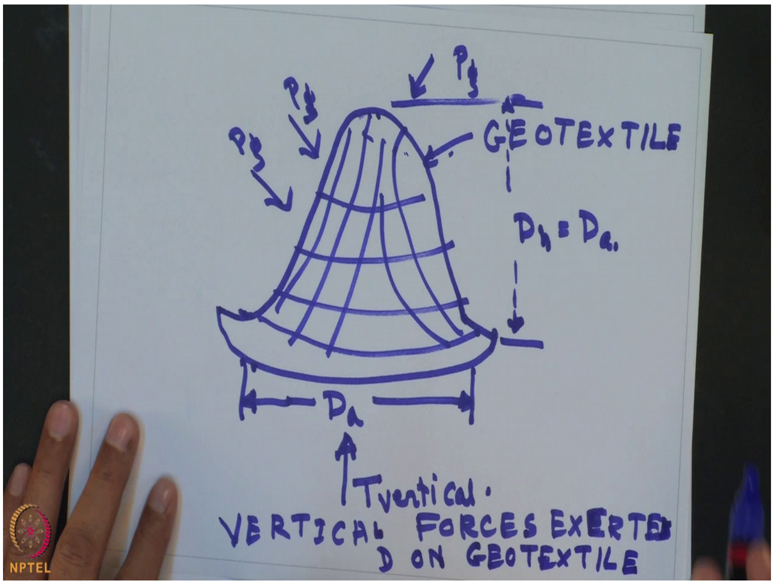

Now, geotextile may puncture due to the presence of soft stone or root during the backfilling of the soil and compaction by the roller and or the traffic load. So, for example, that this is the situation, and this is the geotextile material geotextile material and this distance is let us say the D of a. And this is the T vertical and this distance from here to here is D of h is equal to D of a and this is the P g P of g or you can say this is the also P of g, P of g. So, geotextile may puncture due to the presence of any soft or the stone or root during the backfilling of soil compaction by roller or the traffic load.

So, what is the vertical force exerted on the geotextile that we want to determine. So, what will be the vertical forces exerted on the geotextile exerted on geotextile.

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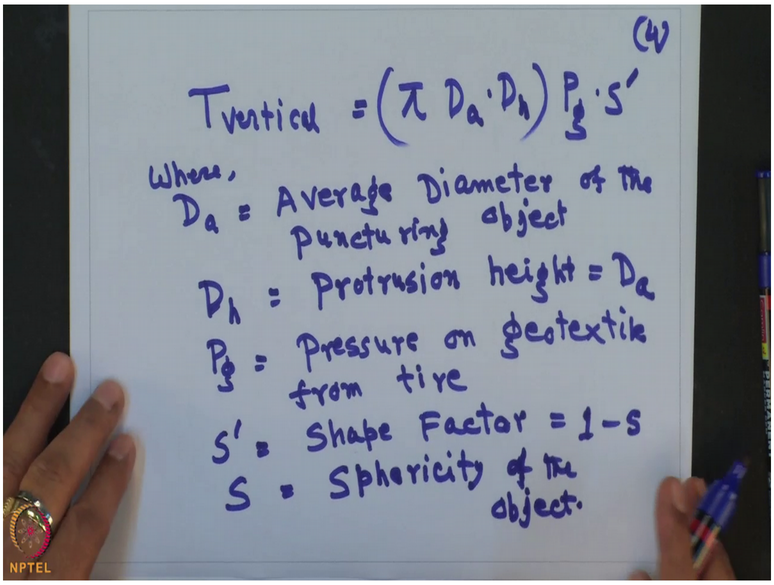

So, this T vertical we can write the equation that T of vertical is equal to pi into D a into D h into P of g into S of dash. So, where D a is equal to 1 D of a is equal to average diameter average of the puncturing objects puncturing object and D h is called protrusion height which is equal to D of a.

That is here we can see D h is equal to D a, this is original height and this is the D a is equal to average diameter of the puncturing object and P g is the pressure on geotextile from tire. So, here is the here is the P g pressure on the tire and S dash is the shape factor shape factor and this is equal to 1 minus S and S is the sphericity of the object sphericity of the object. So, this is the equation you can use for the vertical pressures.

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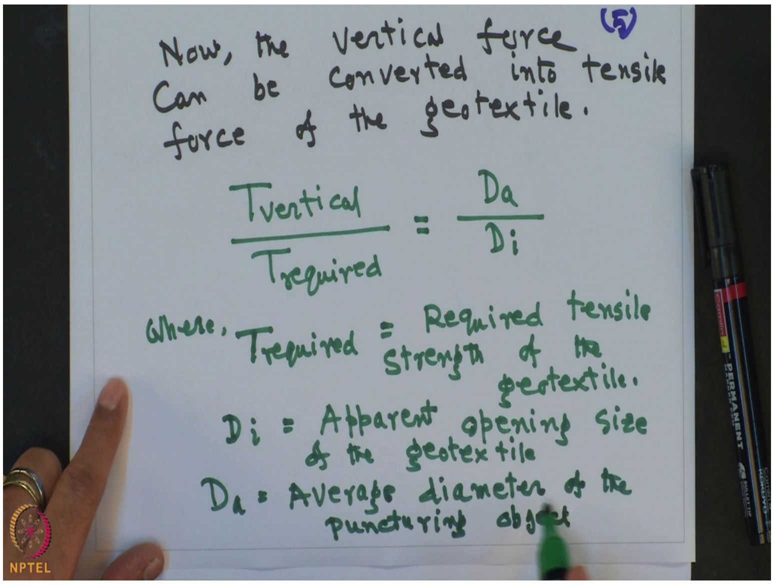

Now, these vertical pressure or force can be converted into the tensile forces. Now, the vertical force can be converted into tensile force of the geotextile. So, then we can write this equation T of vertical divided by T of required is equal to D of a divided by D of I, where I say T required is required tensile strength of the geotextile and D of i is the apparent opening size apparent opening size of the geotextile D i is the apparent opening size of the geotextile and D a you know average diameter average diameter of the puncturing object. So, then we can write the equation.

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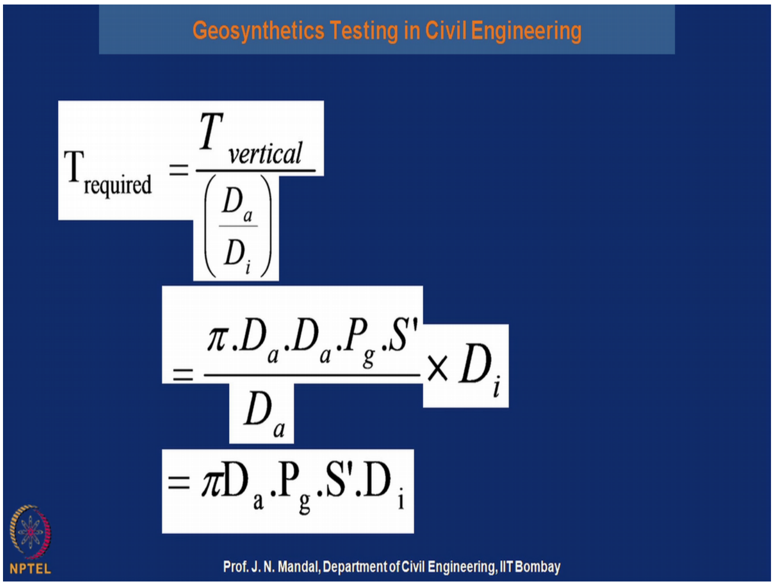

Hence, we can write T required is equal to T of vertical this divided by D a upon D of i. That means, this will be equal to pi into D a into P g into S dash divided by D of a into D of i. So, this we can write pi into D a into P g into S dash into D of i. So, this is the equation for what is the T required. So, what is required for T?

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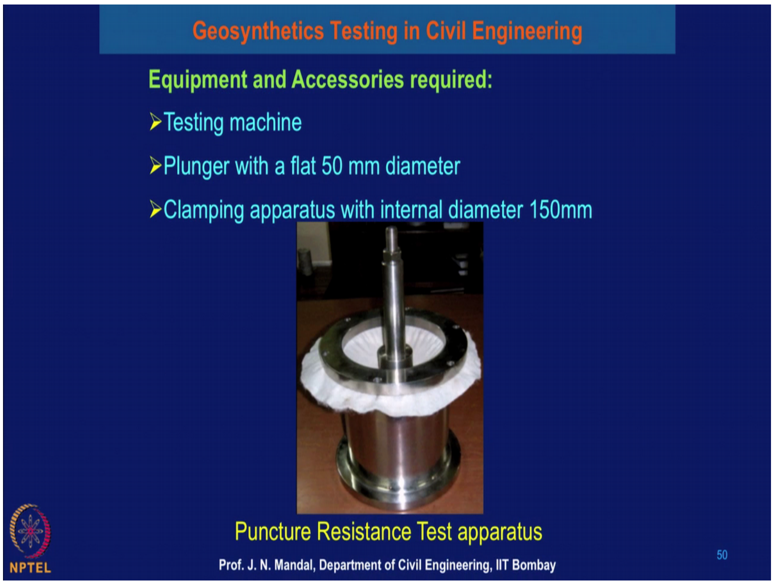

So, what are the equipments and the accessory required for this test. So, you need the testing machine and plunger with a flat of 50 millimeter you can see here diameter and clamping apparatus with internal diameter of 150 millimeter. So, this is the puncture resistance test apparatus and all the apparatus have been indigenously developed in IIT, Bombay.

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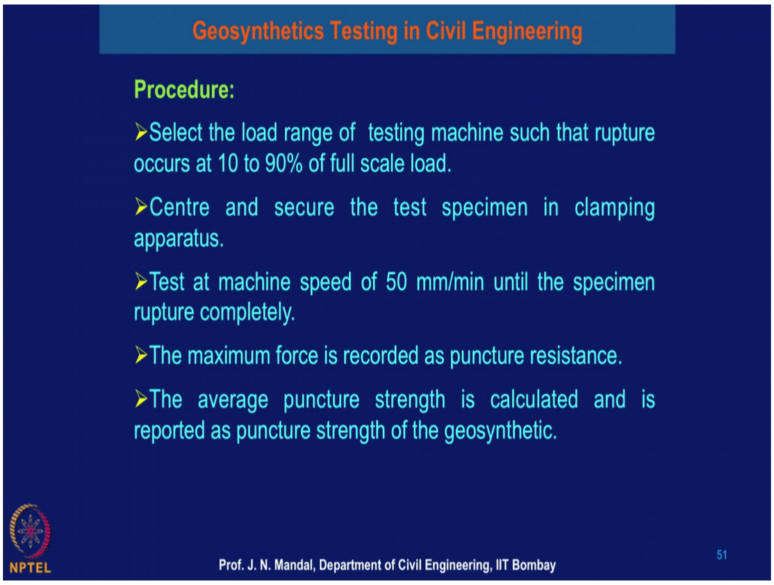

Now, what is the procedure for performing the test? So, you have to select the load range of testing machine such that rupture occur at 10 to 90 percent of full scale load. Centre and secure the test specimen in clamping apparatus. Test at the speed of 50 millimeter per minute until the specimen rupture completely. The maximum force is recorded as puncture resistance. The average puncture strength is calculated and is reported as puncture strength of the geosynthetics material. You had to perform five to six sample and then you take the average and determine what should be the puncture strength of the geosynthetics material.

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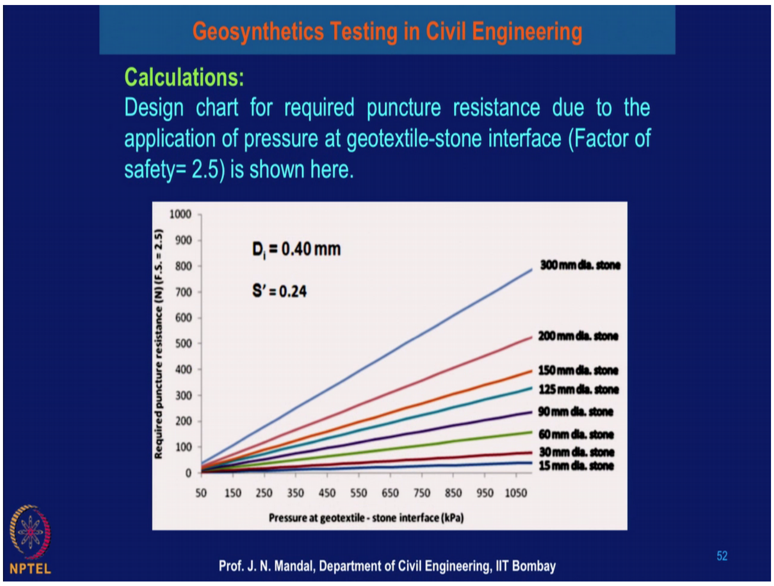

So, from this also we can make that design chart for the required puncture resistance due to the application of the pressure of geotextile material and what should be the pressure at the geotextile stone interface. So, here I am showing you that this is the special geotextile stone interface in kilo Pascal. So, define pressure 50, 150, 250, 350, 450, 550, 650, 750, 850, 950 and 1050.

And, y axis is the required puncture resistance and with a factor of safety is 2.5 and D i mention this is 4.40 millimeter, safe factor S dash is equal to 0.24 and these are the different diameter of the stone. Suppose, if you use 15 millimeter diameter stone, 30 millimeter diameter, 60 millimeter diameter, 90 millimeter diameter, 125 millimeter diameter stone, 150 millimeter diameter stone, 200 millimeter diameter stone or 300 millimeter diameter stone.

So, knowing the pressure or the puncture resistance of the geotextile material for a particular diameter then you can determine what would be the pressure on the geotextile stone base interface. So, whatever the type of the different diameter of the stone material is available on the site. So, accordingly knowing that what will be the pressure at the geotextile stone interface and what will be the required puncture resistance that also we can find out from this diagram.

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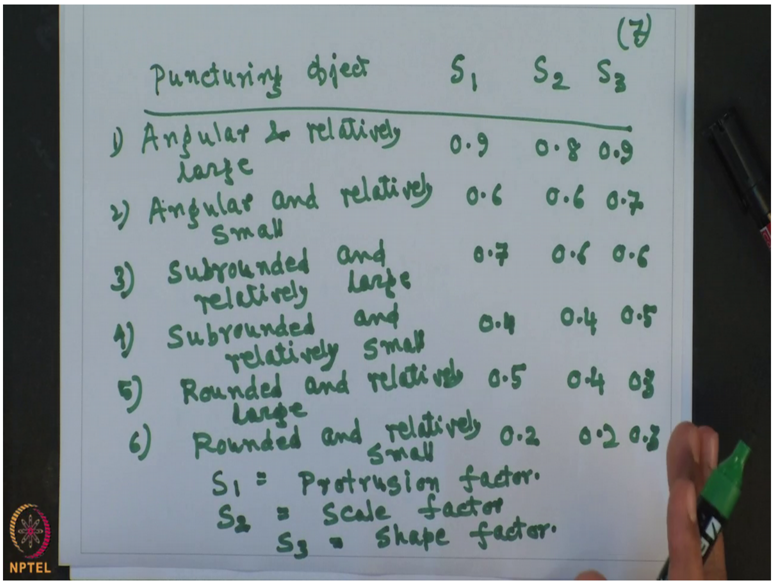

Now, I will say about the recommended some factor used in puncture analysis which is dimensionless. So, we can say this is the puncturing object and define value of S 1, S 2 and the S 3 this is recommended value for factor used in the puncture analysis which is dimensionless. So, for example, if it is a angular and relatively large, so, S 1 value is 0.9, S 2 value is 0.8, S 3 value is 0.9, ok. If it is a angular and relatively small, so, S 1 value is 0.6, S 2 value is 0.6, S 3 value is 0.7.

Third if it is a subrounded subrounded and relatively large then this S 1 value is 0.7, S 2 value is 0.6 and S 3 value is 0.6. If it is subrounded and relatively small then S 1 value is 0.4, S 2 value is 0.4, S 3 value is 0.5. And if it is rounded and relatively large then S 1 value is 0.5, S 2 value is 0.4, S 3 value is 0.3 and if it is a rounded and relatively small then S 1 value is 0.2, S 2 value is 0.2 and S 3 value is 0.3.

So, here that S 1 is called the protrusion factor and S 2 is the scale factor and S 3 is the shape factor. So, depending upon the type of puncturing objective so, you have to take in the equation that what should be S 1 value, S 2 value and S 3. You know if it is the angular and relatively large or if it is angular or relatively small or it is the sub rounded or relatively large sub rounded or relatively small or rounded or relatively large or rounded or relatively small. So, depending upon the various type of the puncturing objective you can take this value that S 1, S 2, S 3 S 3 and then, we can solve the problem.

Thank you.