Geosynthetics Testing Laboratory
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Lecture – 16
Density, Water Absorption and Compressive Properties tests of Geofoam

Now, we will discuss the how to determine the Density of the Geofoam; so this density of the geofoam that as per ASTM D162208. So, here main objective of this to determine the density of the geofoam and it depends upon what will be the size of the sample.

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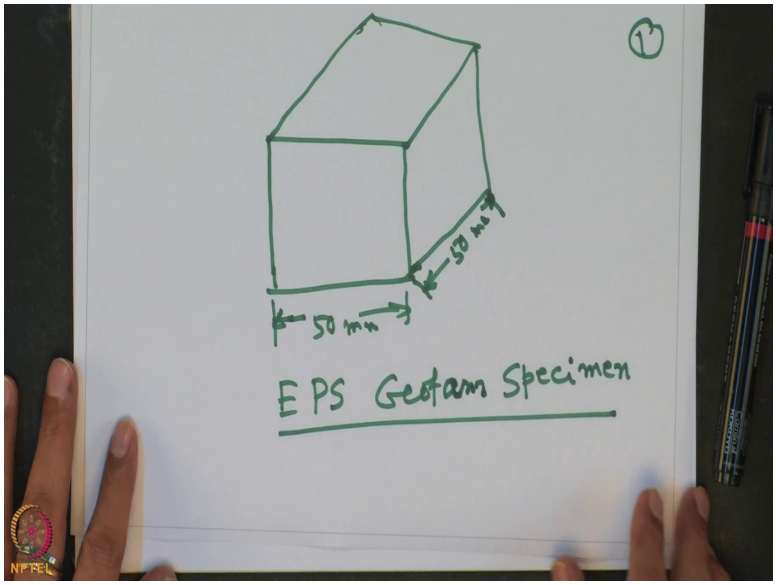

So, you can make the EPS specimen. Generally and this is 50 millimeter. This is a cube and this also it is 50 millimeter. So, this is the EPS or the geofoam EPS geofoam specimen. So, it is EPS geofoam specimen. So, this EPS geofoam specimen has a particular density. So, size of the sample in the cube form and this is the 50 millimeter cube.

Then how to what is the procedure or what will be the apparatus or accessory required for this kind of the test.

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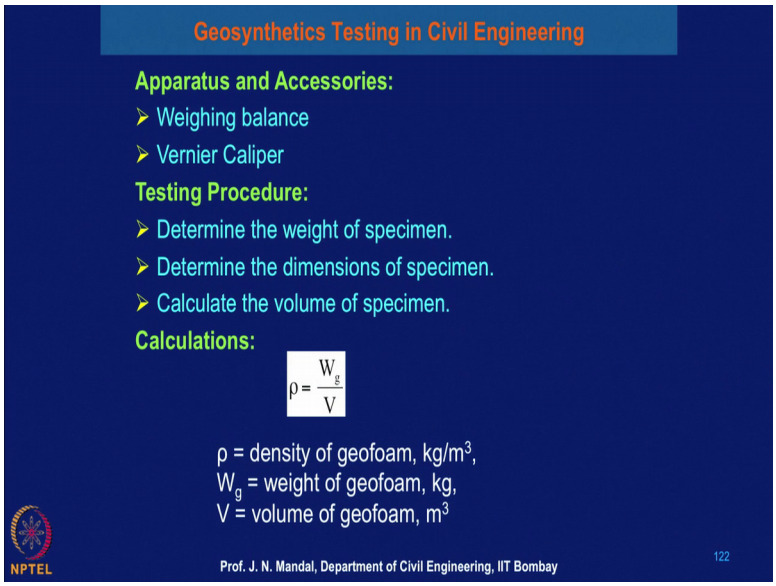

So, you require apparatus one is the Weighting balance; then, Vernier Caliper. And the testing procedure will be first you determine the weight of the specimen; then, you determine the, what will be the dimension of the specimen and from this, you can calculate the what will be the volume of the specimen.

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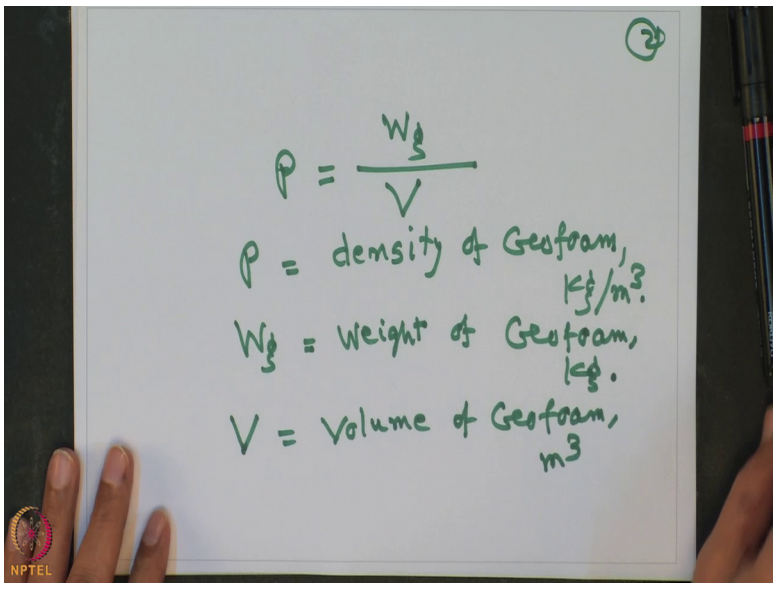

So, in calculation that you can write that if rho is the density; rho is equal to W of g divided by V; where, rho is the density of geofoam, density of geofoam and which can be expressed as kg per meter cube and W g is the weight of geofoam that is unit is kg.

And V is the volume of geofoam. V is the volume of geofoam and that is in meter cube. So, then you have to perform with the different types of the sample and you can have the different volume and different weight and from that you can calculate the density.

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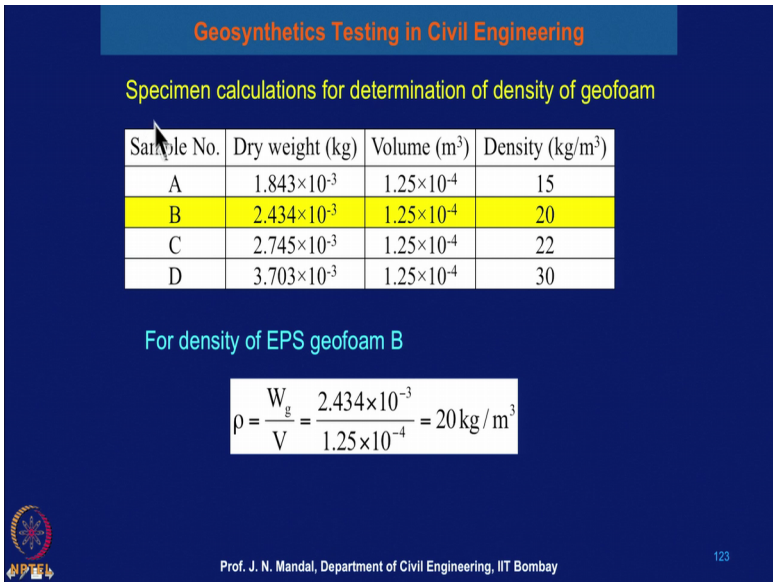

For an example, I am showing you here that this is the some specimen calculation for determined density of the geofoam. So, you take the different sample number A B C D and this has a dry weight in kg, you know the volume in meter cube and density in kg per meter cube.

For example I am showing one of the sample. Sample number let us say B and its dry weight is 2.434 into 10 to the power minus 3 kg and volume of the geofoam sample is 1.25 into 10 to the power minus 4 and this density will be about 20 and you can see here for density of EPS geofoam B is density is equal to rho is equal to W g by V and weight is 2.434 in to 10 to the power minus 3. This divided by the volume is 1.25 into 10 to the power minus 4. So, this will give you the 20 kg per meter cube.

Similarly, you can also that determine what will be density under the different the sample and the like a A C and D and also you can determine what should be the density of the different sample. For example, here for the sample A density is 15 kg per meter cube. For the sample B, as I as I show you for the sample B, the density 20 kg per meter cube. For the sample C, density is 20 two kg per meter cube and for the sample this is D the density about 30 30 30 kg per meter cube.

So, there are different types of the density of the sample. So, you have to select that what kind of density of the geofoam material required for a specific application. It maybe sometimes 15, sometimes 20, sometimes 25, sometimes 30, 32, 40, 42 depend upon the different types of the infrastructure application. So, you know that how to determine the density of the geofoam material. This is very important.

Next, we will discuss that what should be the water absorption capacity of the geofoam material because when you are using for the construction of the road as a filling material or when you are using at the back of the retaining wall as a compressible inclusion. So, one should know, what will be the water absorption capacity of the geofoam material and water absorption capacity of the geofoam material can be determined as per the ASTM C272-01. So, here main objective is to determine the water absorption capacity of the geofoam material.

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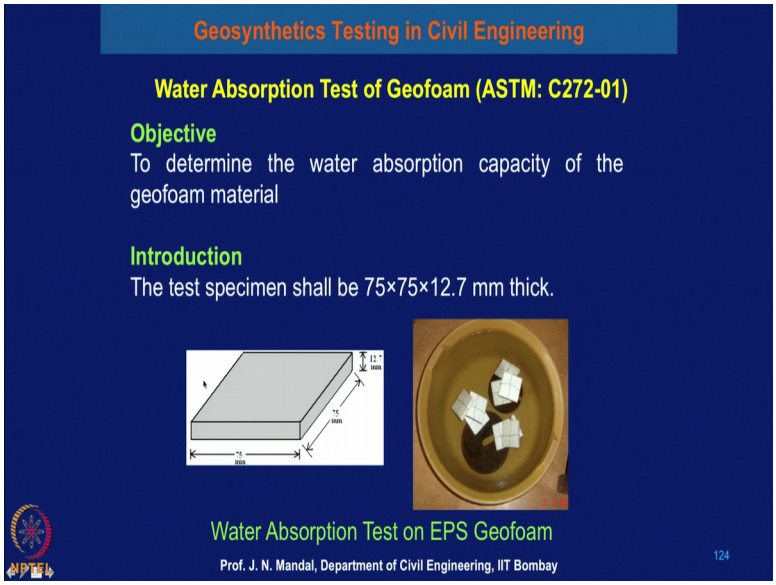

And a test of the specimen, here you can see the sample; sample here that this is 75 by 75 and 12.7 millimeter thick. So, this is water absorption test on EPS. So, this is the sample of the geofoam sample whose size is 75 into 75 into 70 12.7 millimeter thick and then, you have to place this geofoam material into this water.

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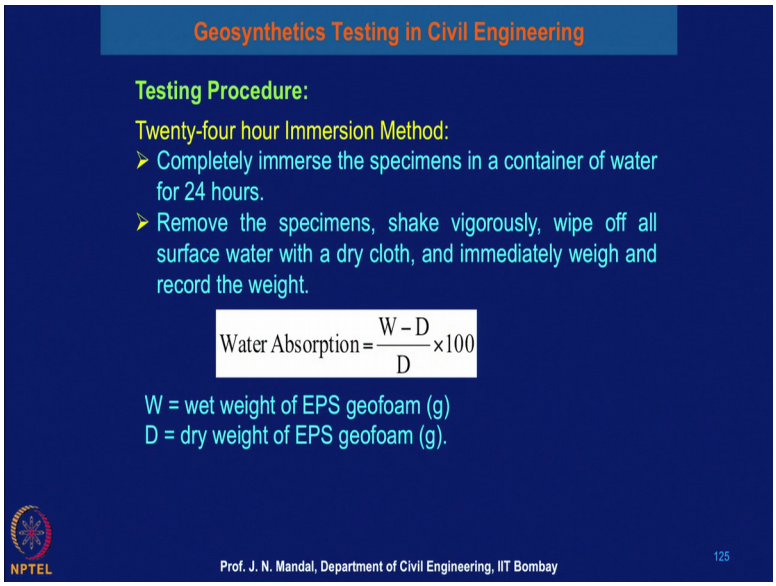

So, testing procedure is 24 hours immersion method and this is completely immersed; completely immerse the specimen in a container of water for 24 hour. Remove the specimens, shake vigorously, wipe off all the surface of water with a dry cloth, and immediately weighed and record the weight.

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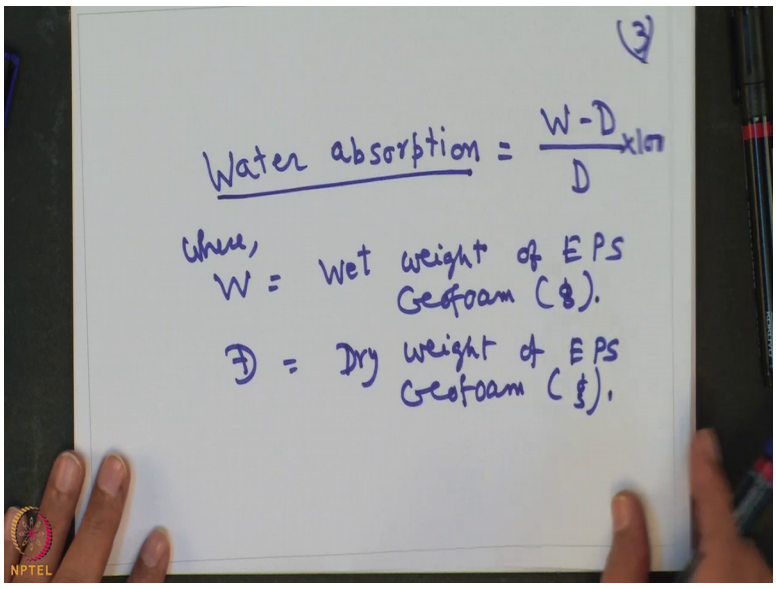

So, water absorption capacity, you can write that water absorption capacity like this equation. Water absorption, water absorption is equal to W minus D divided by D into 100. So, where, W is the wet weight; wet weight of EPS geofoam. So, this is in gram and

D is the dry weight; dry weight of EPS geofoam and this is in gram. So, you know what will be the wet weight and what will be the dry weight; then you can calculate what will be the water absorption capacity. I am showing you one table and then how you can calculate the water absorption capacity.

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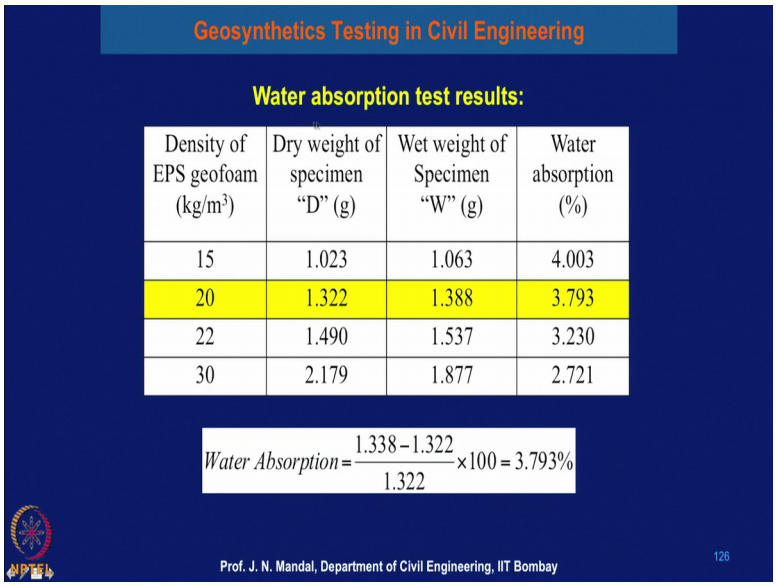

Here, here you can see water absorption test result. So, this is density of the geofoam kg per metre cube. This is different density 15, 20, 22, 30. So, I will show you only that what will be the water absorption capacity for 20 density. So, this is the dry weight of the specimen "D" in gram and for 20, it is 1.322 dry weight of the geofoam material and then you imagine for the 24 hour and then, your wet weight of the specimen is 1.388 gram.

So, then water absorption capacity, you can determine knowing the value of the wet and dry weight of the geofoam material; then, water absorption capacity 3.793. So, here water absorption capacity, as I showed you the equation earlier this is the wet weight 1.388 minus this is the dry weight 1.322 divided by that this 1.322 dry weight into 100 which will give you that 3.793 percentage.

So, this is the water absorption capacity of the geofoam material whose density is 20. Similarly, I am shown in this table for different density 15, 22 and 30 whose water absorption capacity maybe 4, 3, 2, 0.72. So, it is almost you can rather say that it is 3; sometimes 2, 5, 6 percentage of water absorption capacity is bearing and this also very

important that if you perform even than water absorption capacity, the same sample you can find that this compressible inclusion also, it is more. And also there is a bouncy effect. So, this density is very important and one also should know what should be the water absorption capacity of the geofoam material.

Now, we will discuss the Compressive Properties of the Geofoam material.

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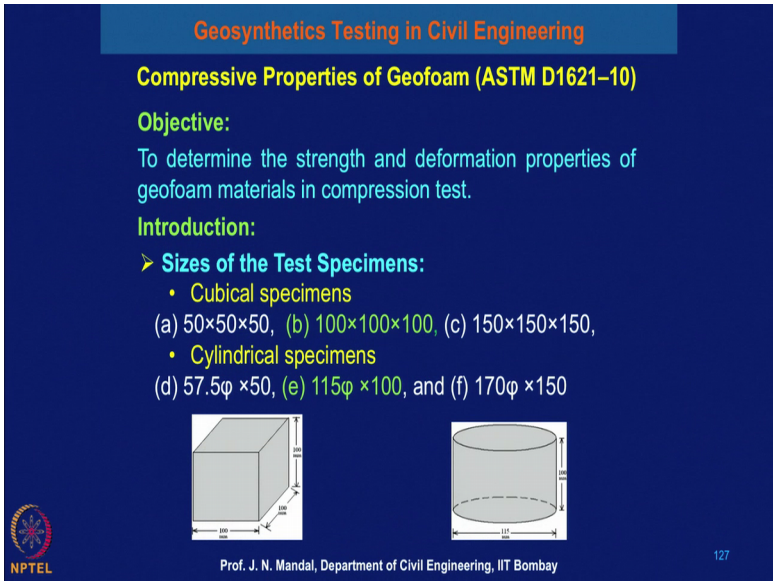

Compressive is very very important; you can use on the back of the retaining wall what would be the compressible inclusion, you can use in the cinema hall also sometime place the geofoam block or you can use geofoam block for the construction of the highway using the EPS geofoam material. So, what should be the compressive strength of the geofoam material? So, this is very important and one should know how to perform this compressive strength of the geofoam material and we will discuss this as per the specification ASTM D162110.

So, main objective of this test to determine the strength and the deformation property of the geofoam material in compression test. So, size of the test sample, it maybe cubical specimen, it maybe 50 50 50 millimeter or it may be 100 100 100 millimeter or it may be 150 150 and 150 millimeter and latest also most of the time you can use 50 50 50 millimeter and it has a certain rate also. And simultaneously, you can use this material in the form of cylindrical specimen and whose diameter about 57.5 into 50 or it may be 115 into 100 or 170 diameters into 50.

Here, is the just two sample and I am just showing, here is the cubical; this is the here it is a cubical and here it is a kind of the cylindrical. This is cubical 50 50 50 or 100 100 100 and this is a cylindrical it maybe 57.5 or 50. So, this is the different type of the sample. So, here compressive strength of the specimen for different density is shown.

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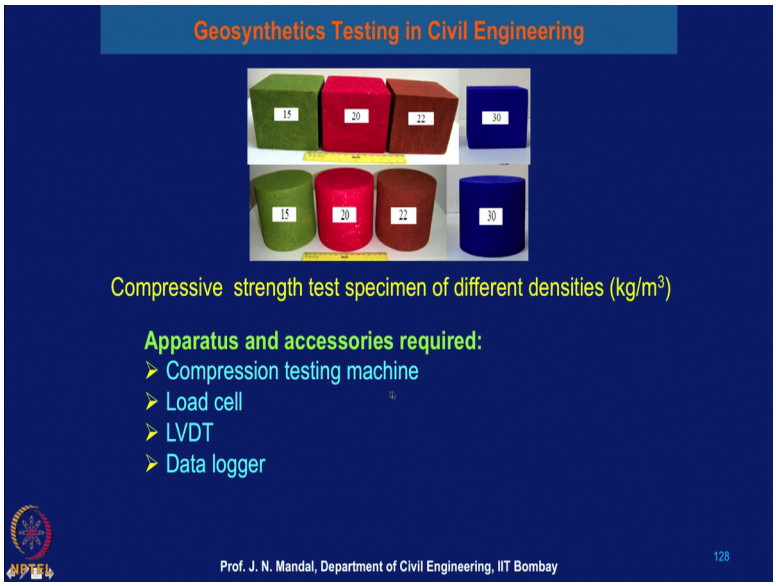

So, we can see in color, it has given because it has a different density. So, this is 15; this is 20; this is 22 and this is 30 and this is in the cubical form. And this is in the cylindrical form with the different density, it may be 15 20 and 22 and 30. So, we have to determine, what will be the compressive strength of the test specimen of different density which unit is kg per meter cube.

So, what is the apparatus and accessory required? Compression testing machine; you need Load cell, you need LVDT and you need the Data logger for recording the data.

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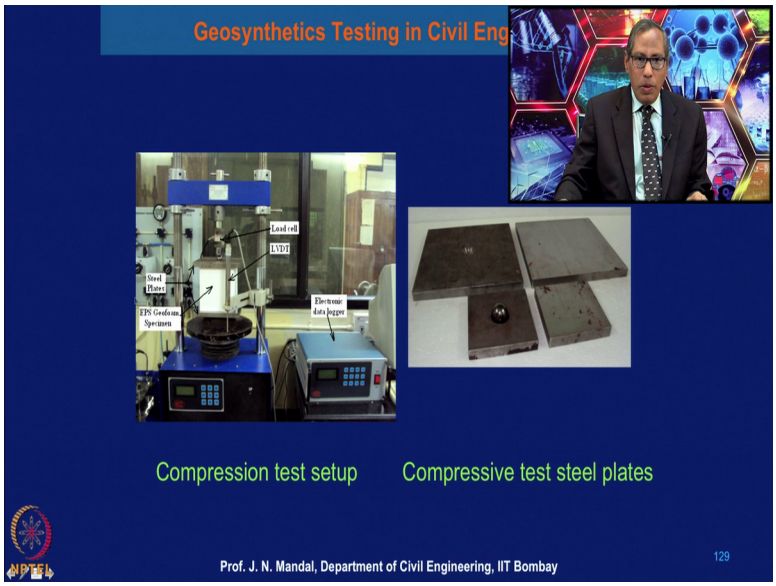

So, here we are showing you the compressive test setup. Here is a compressive test setup and this are the compressive test steel plate which you are placed on the top and bottom of this sample. Here, it may be the rectangular and here it may be the cylindrical or it may be the cubical. So, you are placing this geofoam sample here by universal testing machine and then, you are applying the load and if we apply the load, the material will be material will be compressed and then, you have to measure under what compressive stress and what will be the corresponding strain and how the sample filled.

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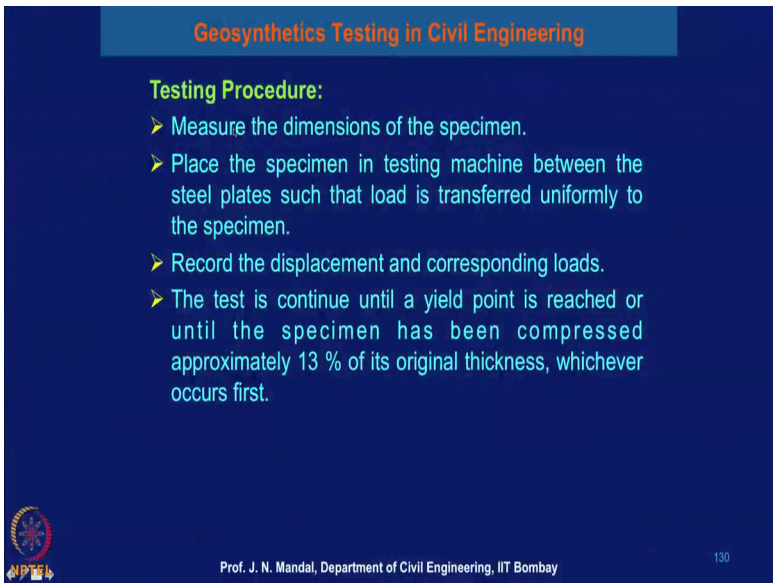

So, testing procedure will be that first you measure the dimension of the specimen and place the specimen in testing machine between the steel plate such that load is transferred uniformly to the specimen and record the displacement and the corresponding load. The test is continue until a yield point is reached or until the specimen has been compressed approximately 13 percent of its original thickness whichever occur first. So, these are the testing procedure, one has to maintain and you can draw the different types of the shear strain curve for the geofoam material.

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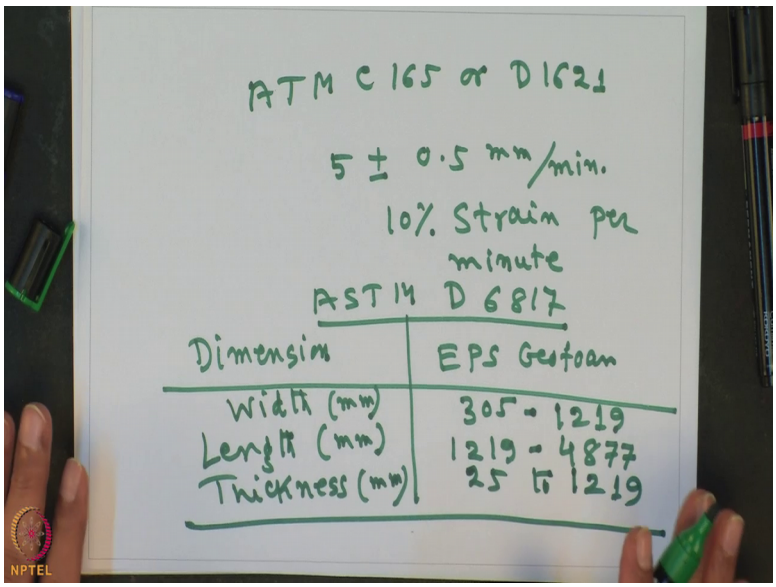

Now, this geofoam compressible inclusion also you can determine as per you know ASTM ASTM C165 or D1621 and cross sectional movement will be 5 plus minus 0.5 this millimeter and per minute or you can say the equivalent to 10 percentage strain per minute. So, this is important that one should know what should be the strain rate of the machine.

So, this one has to maintain and commonly manufacturing dimension of the geofoam according to the ASTM that is D6817, according to the, these the dimension, these are all kind of the EPS geofoam ok. It has a width is millimeter. This is 305 to 1219 and length is millimeter this is 1219 to 4877 and the thickness in millimeter this is 25 to 1219. So, this is the commonly used manufacturing dimension of the EPS geofoam material.

Now, from this test, you can draw the relationship between the, what will be the compressive stress and the corresponding strain. I will now show you the different stress strain curve for the geofoam material under different density of the geofoam.

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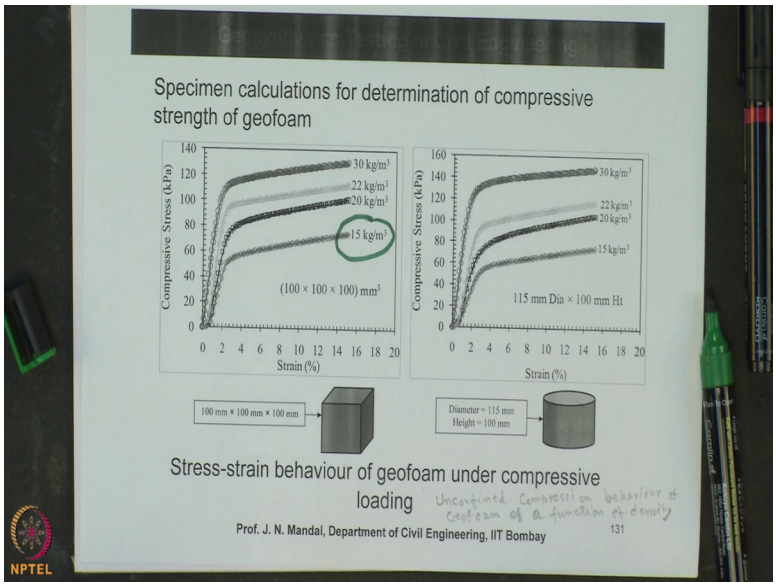

For example, here I am showing you that here this is the specimen calculation for the dimension determination of the compressive strength of the geofoam material.

So, this is strain in percentage and this is stress in compressive stress in kilopascal and the size of the sample may be 100 100 100 millimeter cube; it maybe 50 50 50 millimeter cube also. So, this is the stress strain curve for a particular geofoam density, 15 kg per meter square. This is the density. Then, next is 20; this is 22 and this is 30 kg per meter cube. So, when the sample size is 100 millimeter into 100 millimeter 100 millimeter. So, for a particular strain value, you can determine what should be the compressive stress. So, compressive stress you can determine at 1 percentage, at the 5 percentage and the 10 percentage.

So, depending upon the type of application, you can determine what will be the compressive stress. Because you know what will be the strain, you know what will be the compressive stress value corresponding to the strain, you can also determine what should be the modulus of the geofoam value knowing the value of the compressive stress and the strain. And alternatively, you can also perform the test in the cylindrical form.

So, here I am showing you some result when diameter of this is 150 millimeter and height of the sample is 100 millimeter. This is in the cylindrical form and here is shown the compressive stress versus strain relation for the cylindrical geofoam sample. So, this is the stress strain curve under the different density of the geofoam 15, 20, 22 and 30 kg.

So, this is you can have a look that how the stress strain behavior of the geofoam under the compressive strain and these are all the unconfined compressive compression behavior of the geofoam as a function of the density, as a function of the density. So, I will show you next one typical curve for stress strain curve.

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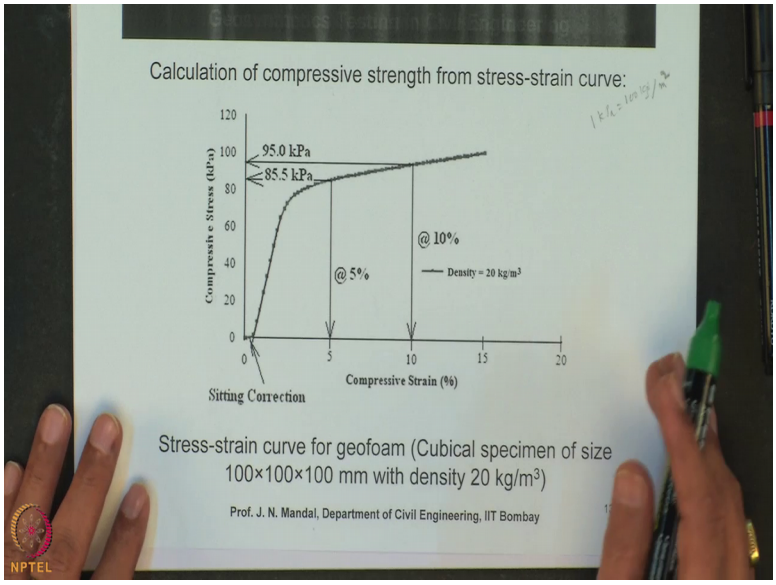

So, here it is the calculation for compressive strength from stress strain curve. So, here is the sitting correction here and this is the compressive strain and this is the compressive stress value in kilopascal from the density of the geofoam is 20 kg per meter cube.

So, you can determine for the 1 percent; you can determine for the 5 percent; you can determine for the 10 percent. So, when that it is a 5 percent strain compressive strain, then compressive stress of the geofoam is 85.5 kilo pascal. When it is 10 percentage of the compressive strain of the geofoam, then compressive stress is 95 kg per meter cube. So, here these diagram show the stress strain curve of the geofoam cubical specimen of size 100 millimeter into 100 millimeter into 100 millimeter for the density of 20 kg per meter cube.

So, from this test also you can determine what should be the modulus of the geosynthetics material; what should be the modulus of the geosynthetics material. So, that is also important because you know that what will be the stress, what will be the strain; then, you can determine the modulus value.

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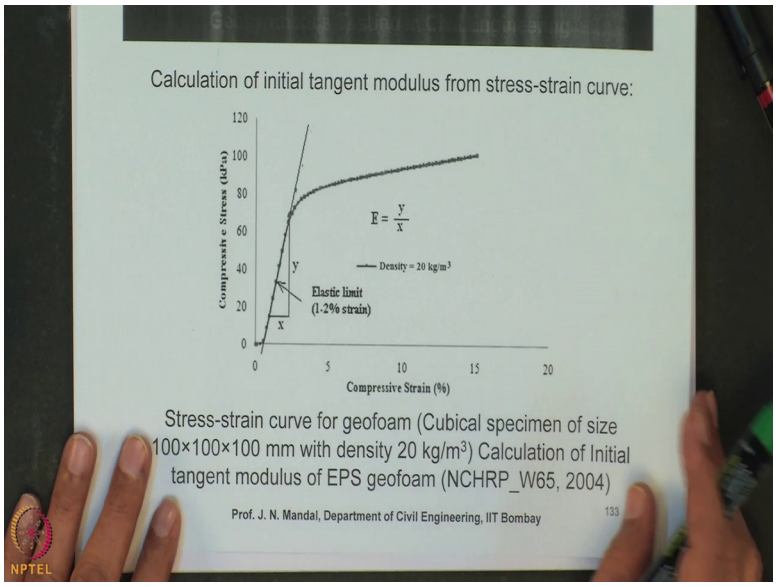

So, here I am showing this is the stress compressive stress verses compressive strain curve of a geofoam. This is the cubical specimen size is 100 millimeter into 100 millimeter into 100 millimeter of density of 20 kg per meter cube. So, here to calculate what will be the initial tangent modulus of the EPS geofoam. So, here the, this is the stress strain curve is shown and you draw a tangent here, you draw a tangent here.

So, this is the slope of this tangent this is y this is x. So, this is elastic limit range between 1 to 2 percentage of strain. So, you know that the slope of the curve will give you that what will be the initial tangent modulus. So, initial tangent E will be equal to y by x. You know what will be the strain and you know what will be the compressive stress, then you can determine what will be the modulus of the EPS geofoam material.

Next some more value I am showing it here from this test.

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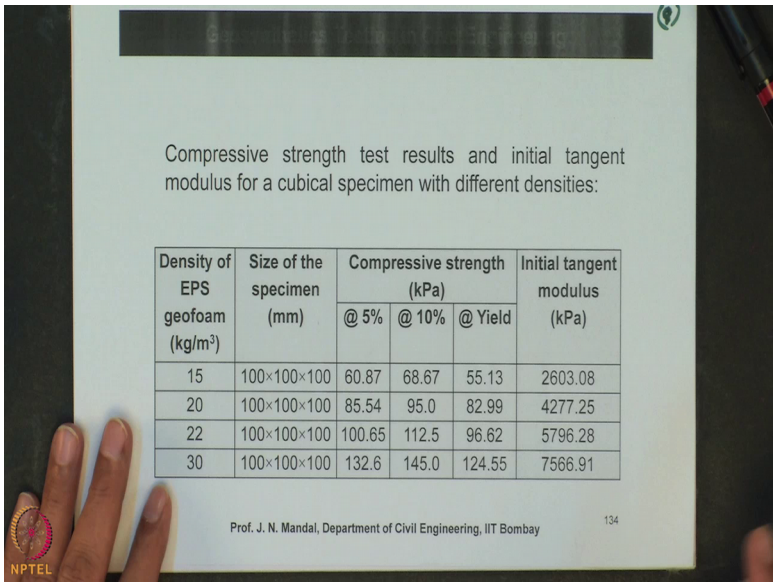

And this is the compressive strength test result and the initial tangent modulus of cubical specimen with different density. Here, is the density of the EPS geofoam. It may be 15 or 20, 22 or 30 kg per meter cube and size of the sample in all density we have kept constant 100, 100 and 100 millimeter. So, compressive strength in kilopascal at the 5 percent strain, then it is 60.87; for a density of 15 kg per meter cube 85.54; for a density of 20 kg per meter cube and 100.65; for a density of 22 kg per meter cube and 132.6 for a density of 30 kg per meter cube.

Similarly, for the 10 percentage, this strain value is on the higher 68.87, 95 and 112.5 145 and then, you can also determine what should be the yield value. So, yield value for the 15, 55.13; for the 20 density is 82.99; for the 22 density 96.62 and for the 30, density of EPS geofoam 124.55. You can also calculate that what should be the initial tangent modulus. So, initial tangent modulus, you know what will be the compressive stress and the strain because you know under what strain value it is. So, you can determine the initial tangent modulus, you know the, what is y; what is x, the slope of the curve.

So, for a density of 15 kg meter cube the initial tangent modulus 2603.08 kilopascal; where the 20 density, it is 4277.25 kilopascal and for 22 density, it is 5796.28 kilopascal and for 30 density, it is 7566.91 density. Here, you can find that the density of the EPS geofoam is increasing, the compressive stress value also it is increasing and at the same time that initial tangent modulus value also increasing.

So, here is a question that you know how to evaluate the compressive stress and the initial tangent modulus or second modulus of the geofoam material and when you wanted to use the compressive stress of the geofoam material. So, initially, you should know what will be the strain value required for the soil and then what strain value you wanted to adopt for a particular structure. So, if you know that this is the compressive stress value for this particular densities required, I need whether 200 or 300 kilopascal compressive stress value, you should know what will be the bearing capacity of the soil in that zone.

And what compressive strain value you required for the geofoam material and sometimes also when you wanted to use that used at the back of the retaining wall. So, you should know what will be the compressive strain? Because in the back of the retaining wall you use the geofoam material have a compressible inclusion.

So, here you are to be select the most important 2 parameter; one is the, what will be the thickness of the geofoam material? That we will discuss later on and then, you should know that thickness of the geofoam depend upon what would be the creep value of the geofoam material. If you know the creep displacement stress strain time temperature curve, then you can determine the, what should be the thickness of the geofoam required as a compressive inclusion and the back of the retaining wall.

At the same time, you should know what should be the compressive strength of the geofoam material because geofoam material density depends also on the lateral pressure which is inserted into the back of the retaining wall. So, how the how the lateral pressure is reduced drastically, when you use the back of the retaining wall. Even then sometimes the lateral pressure tends to 0.

Thank you.