Geosythetics Testing Laboratory
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Lecture – 20
Shear and Flexural Properties of Geofoam

I have shown you earlier how to calculate the shear strength of the EPS geofoam under various densities of EPS geo foam material. Now I will show you how to calculate the shear strain of the EPS geofoam material.

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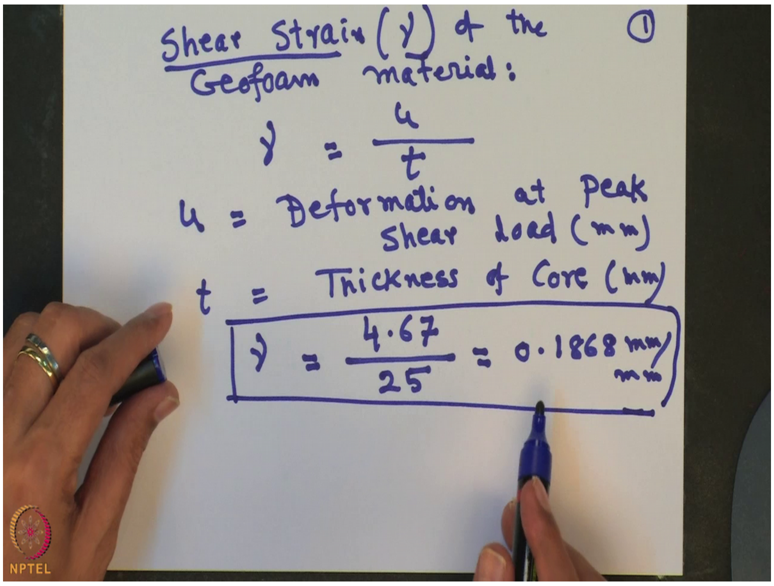

So, you have to calculate the shear strain and that is; let us say gamma of the geofoam material. So, the shear strain is equal to u this divided by t, where u is equal to deformation; deformation, deformation at peak shear load in millimeter. So, deformation at peak shear load in millimeter and this is the t; so, t is the thickness of core this is thickness of core that is in millimeter.

So, this shear strain that is gamma you can determine that deformation at peak value is 4.67; so this is 4.67 ok. And this divided by the thickness of the sample is 25, so this will give the shear strain of the EPS geofoam is 0.1868 millimeter per millimeter.

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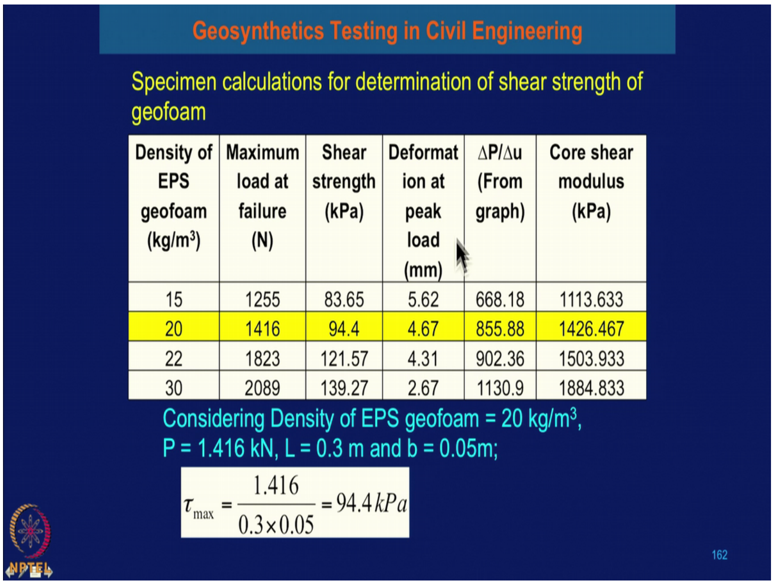

Density of EPS geofoam (kg/m^3)	Maximum load at failure (N)	Shear strength (kPa)	Deformation at peak load (mm)	$\Delta P/\Delta u$ (From graph)	Core shear modulus (kPa)
15	1255	83.65	5.62	668.18	1113.633
20	1416	94.4	4.67	855.88	1426.467
22	1823	121.57	4.31	902.36	1503.933
30	2089	139.27	2.67	1130.9	1884.833

$$\tau_{max} = \frac{1.416}{0.3 \times 0.05} = 94.4\,kPa$$

So, you can see here from this table in this slide where I explained you earlier here from this slides you can see that deformation at peak load is 4.67 ok.

So, we have calculated deformation at peak load at 4.67, so here I am showing that deformation at peak load is 4.67. And t is the thickness of core is 25 and that is why the shear strain value is 4.67 by 25 is equal to 0.1868 millimeter per millimeter. So, you know how to calculate the; how to calculate the shear strain of the EPS geofoam material.

Next I will show you that how to calculate the G value modulus value.

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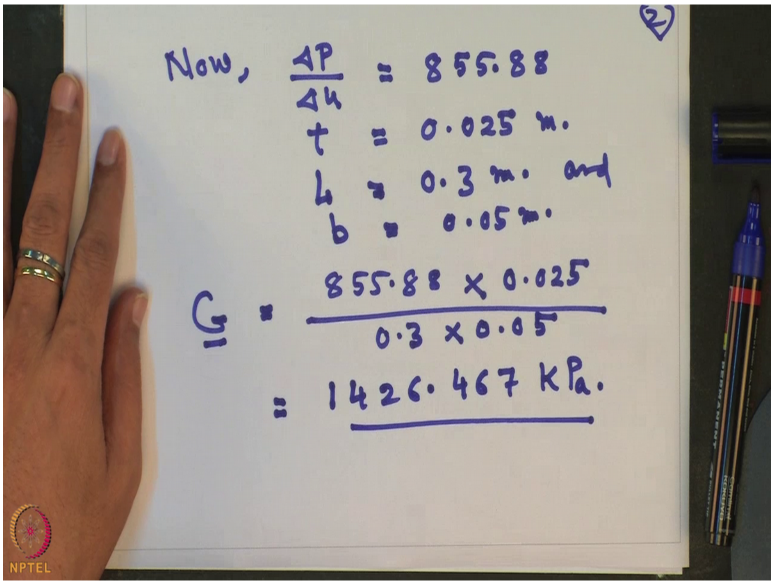

Now, you know del p by del of u is equal to 855.88 and the thickness is 0.025 meter and you know the length of the sample is 0.3 meter and b is equal to 0.05 meter. So, you can calculate from the earlier equation you know delta p; G is equal to delta p by delta u; that means, 855.88. So, 855.88 into t is 0.025 this divided by length is equal to 0.3 into the b is equal to 0.05.

So, this G will be equal to 1426.467 this is kilo Pascal; so, you can calculate the G value. And this value delta p by delta u which you have I have shown you from the earlier table which is shown in the in this table; we can see delta p by delta u is equal to 855.88 for a EPS density of 20. So, core shear modulus value is 1426.467 and here it is shown 1426.267 and 47 kilo (Refer Time: 05:57) this is the modulus value.

So, you know that how to determine the modulus of the EPS geofoam material. So, from this shear strain of the EPS geofoam; you can calculate what will be the shear strength of the EPS geofoam, what will be the strain of the EPS geofoam and also that what will be the modulus of the EPS geofoam material. Next we will discuss the breaking load on flexural properties of the EPS geofoam material because flexural property of EPS geofoam material is important in the different application of civil engineering; how we can make use of the EPS geofoam in civil engineering project for that you require what will be the flexural properties.

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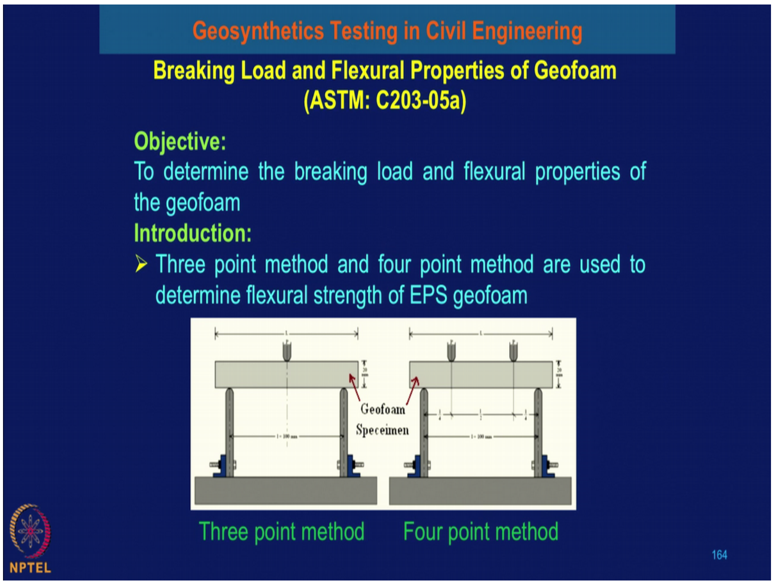

So to to calculate the flexural properties of the geoform material; so, the here is main objective of this to determine the breaking load and flexural properties of geofoam. So, this is the three point method and four point method are used to determine flexural strength of the EPS geofoam material.

So, here I am showing this curve is the three point method; so, you see here this one is the geofoam specimen under three point method. And you are applying the load at the middle of the EPS geofoam here and it is supported by this. So, this length from here to here this capital L is equal to 100 millimeter and this is the sample the; this is above 20 millimeter from here to here is the 20 millimeter; so this is three point method.

Similarly, you can also perform the test under four point method; here is the four point method this side is the four point method. And this distance from here to here is L by 2 this is let us say L 1 and this is L 1 and this is the L. And here also this distance is about 20 millimeter and this small l is equal to 100 millimeter. So, this is the size of specimen in which you can perform 10 of the EPS geofoam material.

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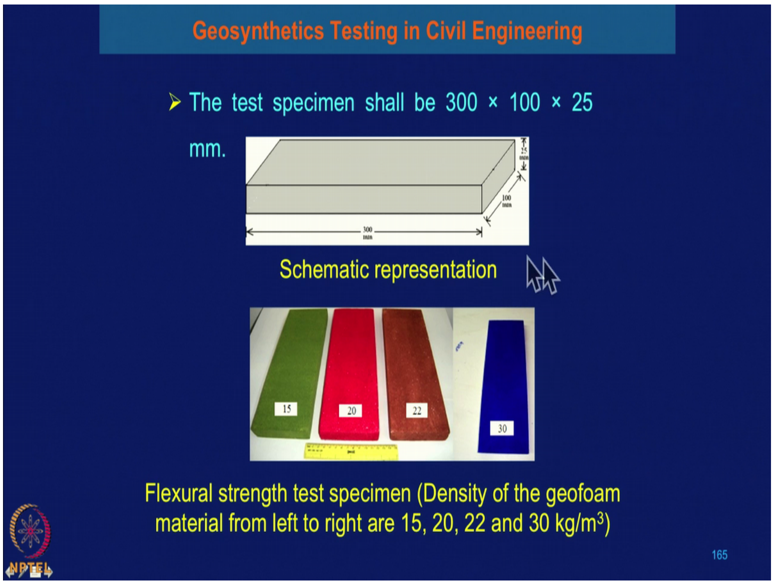

This test specimen as I told you here you can see the specimen should be the 300 by 100 and this is 25 millimeter this is EPS geofoam specimen.

So, you can cut any sample that size will be 300 by 100 millimeter by 25 millimeter. And you can perform the test under different densities of the EPS geofoam material; here I am showing the sample with the different density that is flexural strength test specimen and density for 15 kg per meter cube, this is 20 kg per meter cube, 22 kg per meter cube and 30 kg per meter cube.

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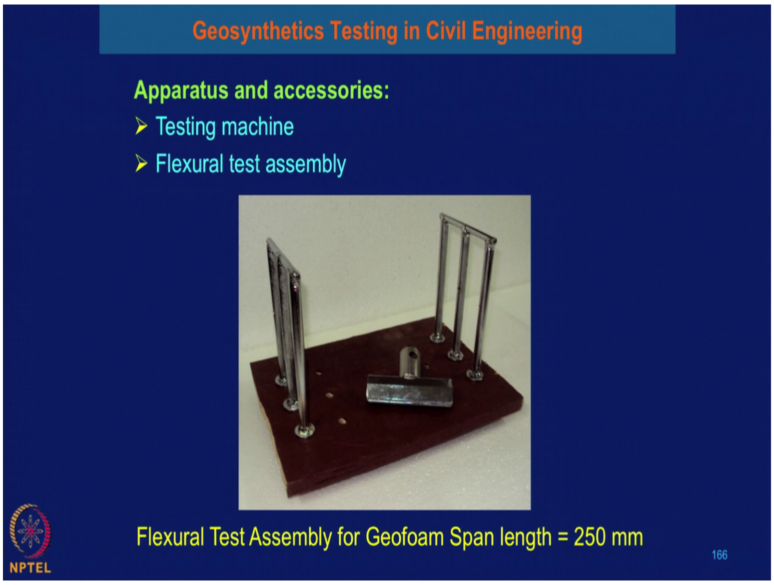

So, this test that what you require the apparatus and accessory; so you require testing machine, you require what will be the flexural test assembly. So, here you can see that flexural test assembly for geofoam span length is about 20 250 millimeter here 250. And these all this equipment has been fabricated indigenously in IIT, Bombay and this test has been performed; so, this is the flexural stress equipment.

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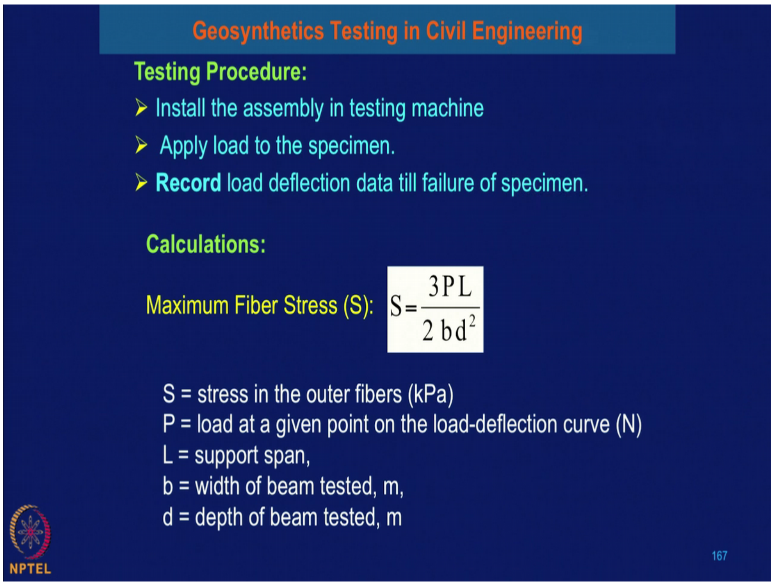

Now, the testing procedure for this install the assembly in the testing machine, apply the load to the specimen and record the load deflection data till failure of the specimen; so, then how to calculate the stress; flexural stress of the geofoam material?

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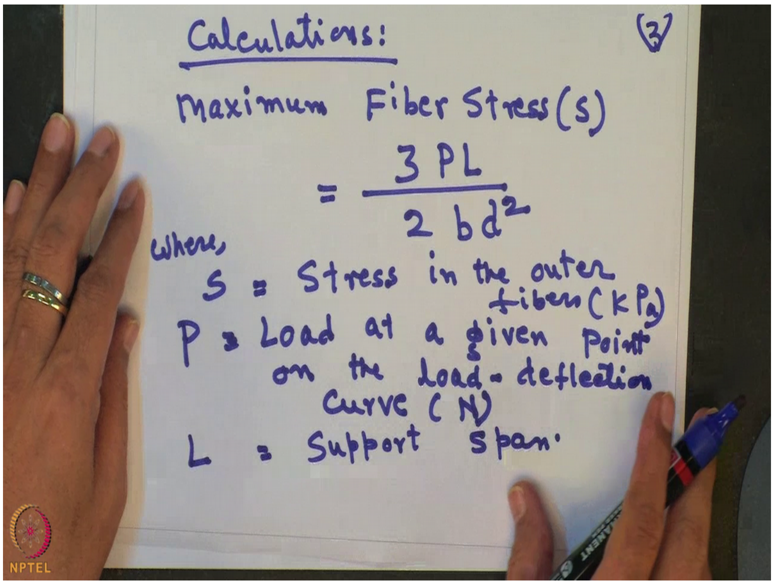

So, for the calculation of the EPS geofoam material in this; we showing some calculation maximum fiber stress say S; S is equal to 3 into P into L, this divided by 2 into b into d square, where S is equal to stress in the outer fiber; outer fiber that is in kilo Pascal; what is P? P is the load at a given point; load at a given point on the load deflection load deflection curve that is in Newton.

And L, this L is the support span; support span and b is the width of the beam tested, width of the beam tested that is meter and d is the depth; depth of beam tested that is meter.

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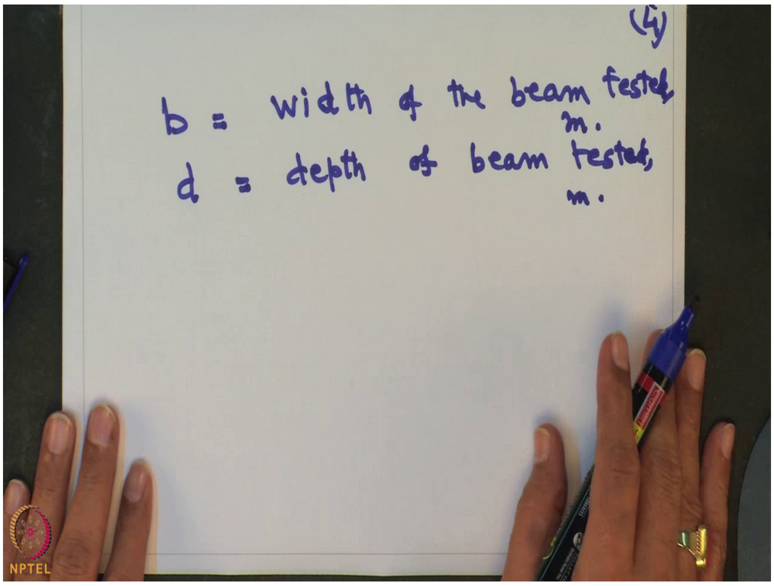

So, you know this equation, what you call maximum fiber shear stress value. So, if you know that what will be the P, what should be the L and you know that what will be the width of the beam and what will be the depth of the beam. So knowing this value of P, L, b and d; so, you can calculate what will be the maximum fiber stress; that means, S. Similarly you can calculate the maximum strain value; maximum strain, maximum strain you can determine that is epsilon.

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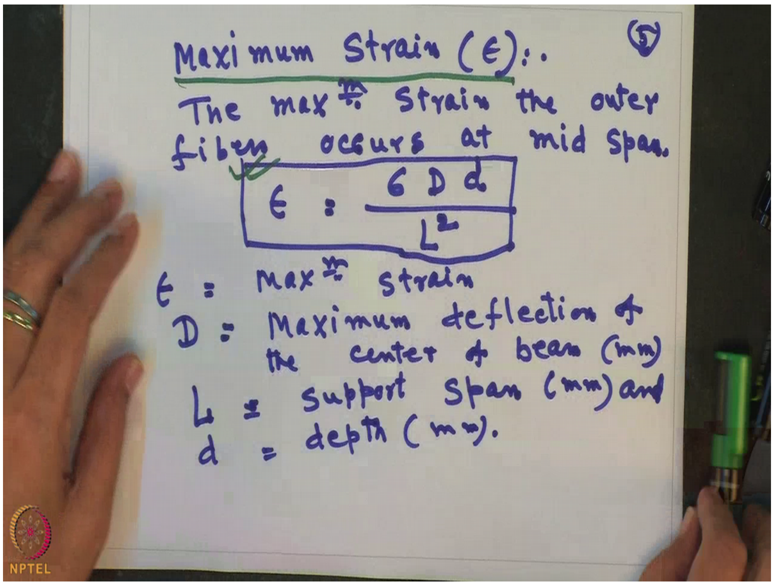

So, the maximum strain in the outer fiber occurs at mid span at mid span; that means, the maximum strain will be equal to 6 into D capital D into small d divided by L square. So, this is the equation for the maximum where you know that epsilon is maximum strain at the outer fiber you know. So, D is the this is maximum strain at the outer fiber.

And D is the maximum deflection; maximum deflection of the centre of beam; maximum deflection of centre of beam this is millimeter. And L you know that what is support span support span in millimeter and what is small d is the depth, depth that is in millimeter.

So, you can determine that what will be the maximum strain of the EPS geofoam material using this equation that epsilon is equal to 6 D d divided by L square, you know what is d the maximum deflection at the centre of the specimen? And you know, what is L? L is equal to support span and d you know what will be the depth; so, you can calculate the maximum strain.

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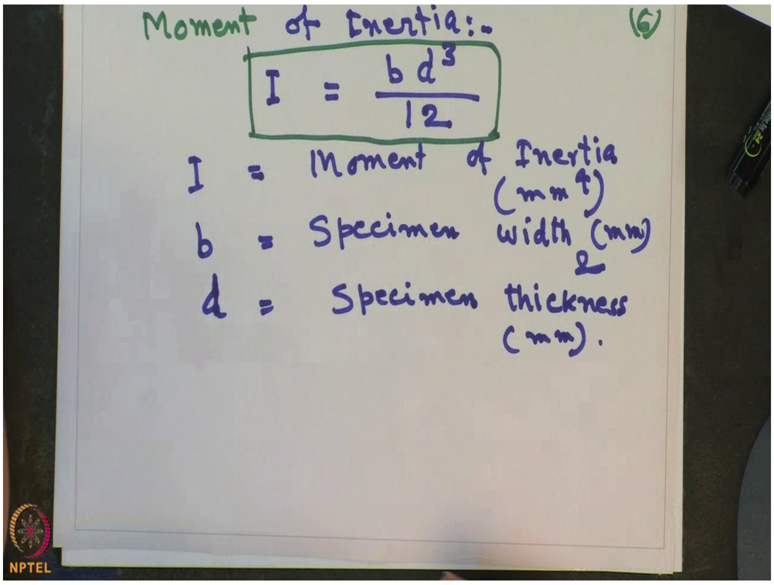

You also can calculate that what will be the inertia; moment of inertia of the EPS geofoam material. So, calculate the moment, moment of inertia and so moment of inertia can be calculated as I is equal to you know b d to the power cube this divided by 12. So, what is I? I is equal to moment of inertia; moment of moment of inertia that is millimeter power 4 and b is the specimen width.

So, b is the specimen width that is in millimeter and d; d, d is the specimen thickness. So, d should be the specimen that thickness; so, this is designated as millimeter. So, you can calculate the moment of inertia and moment of inertia you can calculate within this equation. So, you know what will be the b; specimen width you know what will be the specimen thickness. So, you can determine the moment of inertia using this equation I is equal to b d to the power cube divided by 12.

So, moment of inertia also EPS geofoam can be determined; apart from this moment of inertia, strain you can also determine the; what should be the elastic modulus of the EPS geofoam material.

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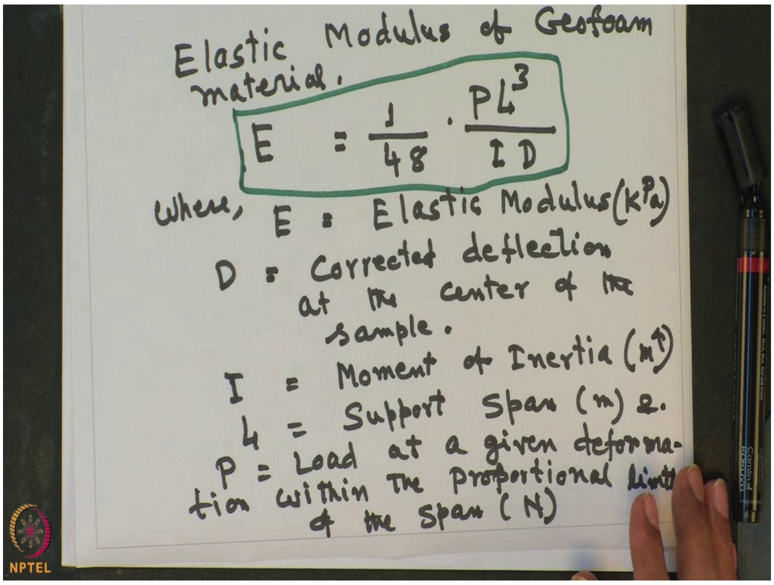

So, elastic modulus of geofoam material are to calculate that is E will be equal to 1; 48 into P into L to the power cube, this divided by I into D. So, where E is equal to elastic modulus; E is elastic modulus and this is kilo Pascal ok. And D is corrected deflection; corrected deflection at the centre of the sample, center of the sample; corrected deflection at the centre of the sample and I is the moment of inertia.

You know earlier we have calculated how to calculate the moment of inertia I is moment of inertia and that is in meter 4. And L is support span, L is equal to support span that is in meter and P is equal to load at a given deformation; so, P is equal to load at a given deformation; deformation, load at a given deformation with the within the proportional limit of the span and that is in Newton.

So, elastic modulus that is that E can be determined with the, this equation. So, you know this equation you know that what should be the elastic modulus of the geofoam material and you know the what will be the d; that is what you call the corrected deflection, you know that what will be the I; already you have calculated earlier that moment of inertia. And also you know that what will be the L that are support of the span and P is the load applied.

So, if you apply this load and you know that what is the load has been applied; the sample (Refer Time: 24:13), so then knowing the value of L, knowing the value of moment of inertia and knowing the value of D; capital D corrected deflection and then you can determine the elastic modulus of the geofoam material. So, you can calculate the moment of inertia, so you can calculate the elastic modulus of the EPS geofoam material.

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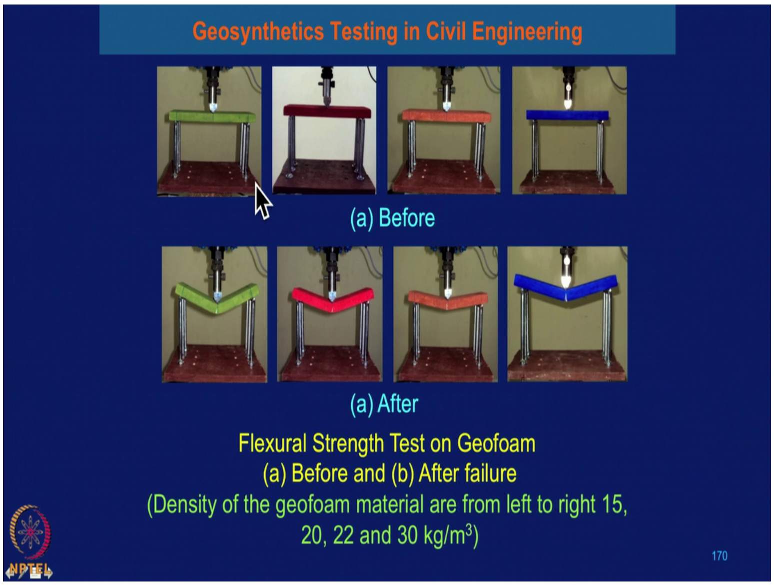

Now, I will show you some of the sample failure in perform the test, you can see here the different geofoam EPS geofoam material on the different density; 15 and this is 20, this is 22 and 30 kg per meter cube. And this is the before the test and you can see that after the test this sample fell at the middle.

So, when you will perform the flexural strength test on the geofoam; you can see how the sample failed here. So, it is middle of the span you can see how the sample failed under 22 kg per meter cube density, when it is 22 kg per meter cube density and the 30 kg per meter cube density.

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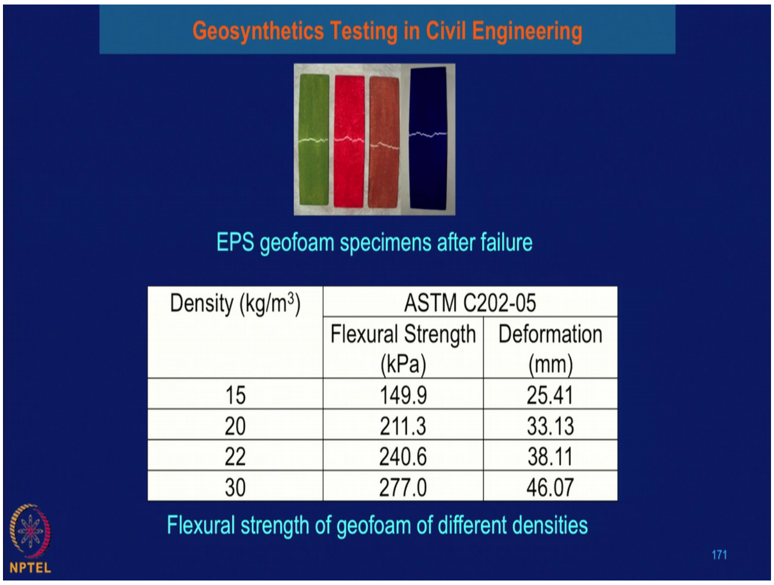

So, from this test here I am showing the same sample EPS geofoam specimen after the failure.

And you can calculate that what should be the flexural strength of the EPS density; EPS geofoam material. So, as per the ASTM C202-05; so, when the density of the EPS geofoam is 15 kg per meter cube; then flexural strength value is 149.9 kilo Pascal, when the and corresponding deformation is 25.41 millimeter. So, when the density of the EPS geofoam is 20 kg per meter cube; then flexural strength is 211.3 kilopascal and the corresponding deformation is 33.13.

When the density of the EPS geofoam is 22 kg per meter cube; then the flexural strength is 240.6 kilo Pascal and corresponding deformation is 38.11. When the density of the EPS geofoam is 30 kg per meter cube; so density flexural strength of the EPS geofoam material will be about 277.0 kilo Pascal and corresponding deformation is 46.07.

So, from this flexural strength of the EPS geofoam material; you will be knowing that what the location the EPS geofoam material has failed; it failed at the center of the span of the EPS geofoam material. And from this test you can determine what should be the flexural strength of the EPS geofoam material, what should be the moment of inertia of the EPS geofoam material, you can also calculate the elastic modulus for EPS geofoam material.

And these are some of the property either is the tensile strength of the EPS geofoam material in what you call the initial tangent modulus or the second modulus or even then that elastic modulus of the EPS geofoam or the moment of inertia will be useful for any numerical analysis or the finite element method analysis.