Geosynthetics Testing Laboratory

Prof. Jnanendra Nath Mandal
Department of Civil Engineering
Indian Institute of Technology, Bombay

Lecture - 5
Tensile Modulus

I am Professor J. N. Mandal, Department of Civil Engineering, IIT; Bombay. We know how to perform the tensile strength of the geosynthetics material, different types of the geosynthetics material have they are different type of strength. It may be woven geotextile material, it may be non woven geotextile material, it may be geogrid, it may be geomembrane or geosynthetics clay liner. So, form the tensile strength of the geotextile; we will calculate the different types of the property.

Here I am showing that method of determining the Tensile Modulus of geosynthetics material.

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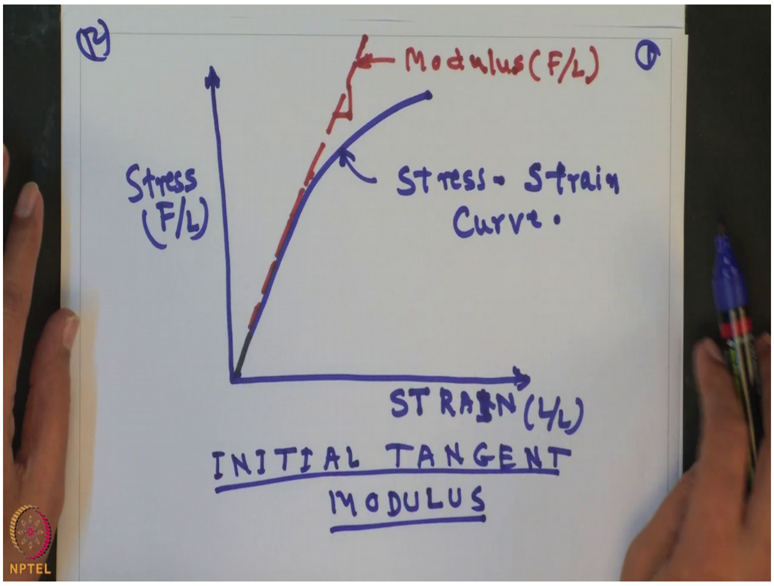

You can draw a relationship between the stress that is F by L in the x axis; y axis and the strain this is L by L in the x axis. So, this nature of the curve let us say stress strain curve of geosynthetics material is like this. So, these are the stress strain curve ok; so, from this stress strain curve; we want to determine that, what will be the initial tangent modulus. So, if we can draw a straight line from the origin tangent to the circle and the slope of this will give you that what is modulus; modulus. So, from this you can calculate the initial tangent modulus.

So, you can determine the initial tangent modulus. So, slope of the curve will give you the initial tangent modulus and this initial tangent modulus will be very much useful for any numerical analysis. Similarly we will determine the offset tangent modulus.

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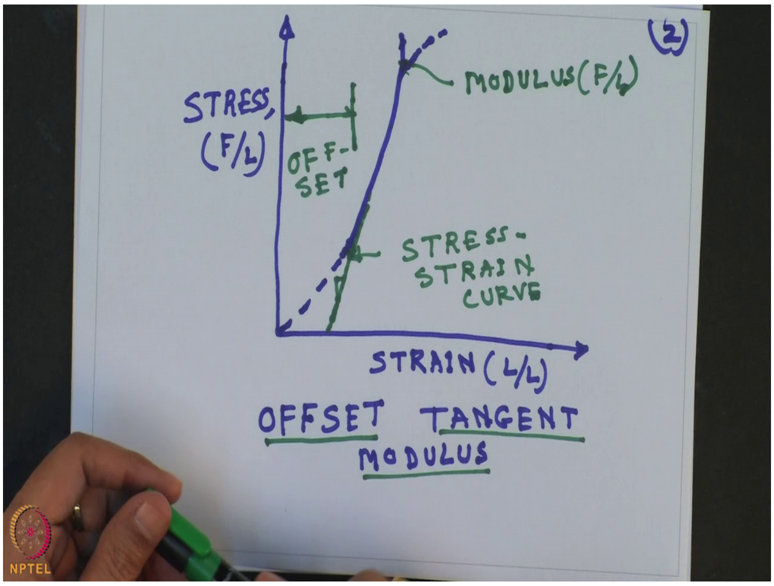

So, define types of the geosynthetics material they give the different types of stress strain curve. So, suppose this is the strain and this is the stress that is F by L.

So, you can have the sum of the curve of the geosynthetics material is like this; is like this. So, this is the nature of the nature of the curve of a geosynthetics material. So, from this nature of the curve you can determine offset, offset tangent modulus; so why you have to do to; how to determine the offset modulus? So, you can take a tangent through this here; so this is the slope. So, this will give you the, what you call stress; stress strain curve and these offset. So, this part is the offset this is the offset.

And this is the modulus that is F by L. So, you can determine the offset tangent modulus of a geosynthetics material. So, this is the stress strain curve and this is the offset; so, you can take the slope which will give you that modulus that is this called the offset tangent modulus.

Now, you can have the other type of the property, which you call the second modulus at a desired strain.

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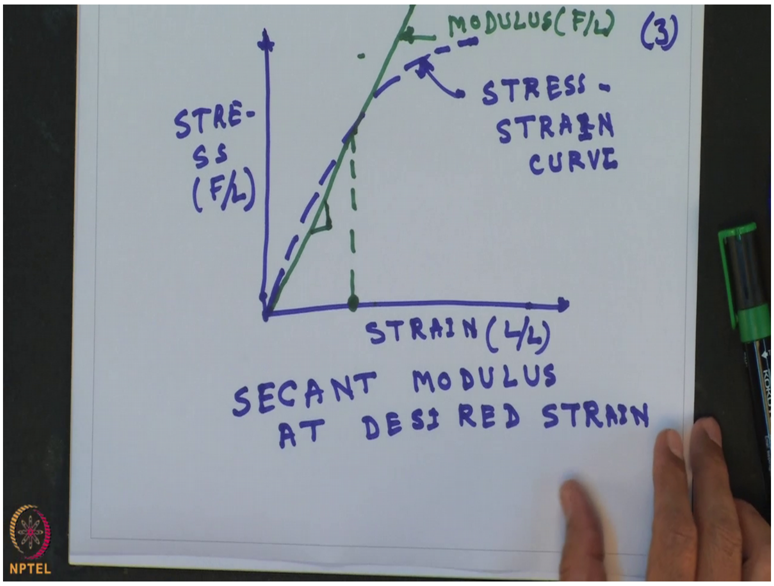

So, if you draw the stress strain curve of geosynthetics material for example, this is the strain this L by L and these are the stress that is F by L. So, you can have the sometimes that stress strain curve; let us say like this like this. So, this will give you that what is the stress, stress strain curve stress strain curve. So, you can determine from this stress strain curve what should be the second modulus at desired strain? So, you can determine the second modulus second modulus at desired; desired strain.

And this value is very important for the design of any kind of the geosynthetics reinforce or related structure. For example, if you wanted to construct a reinforce payment, then you need that what would be the second modulus and the corresponding strain value. So for any strain value if you take if you take this value and then for a particular strain; so, it is the strain for a particular strain you can draw a line you can draw a line.

So, which will give you the modulus that is F by L; for any desired strain that is this slope will give you the second modulus. If this is the peak value, you can take half of the peak value with corresponding strain or one third to two third with the corresponding maximum value or you can decide any strain value. And then you will be knowing that what will be the slope of this line and which will give you the second modulus of the geosynthetics material.

I will give you one example; how to determine the all the modulus value. So, as I said for different geosynthetics material; it may be non woven, it may be heat bonded, it maybe needle punched material and they have their different thickness. So, properties of the different geosynthetics material will be the different; for an example that we are considering a non woven geotextile material.

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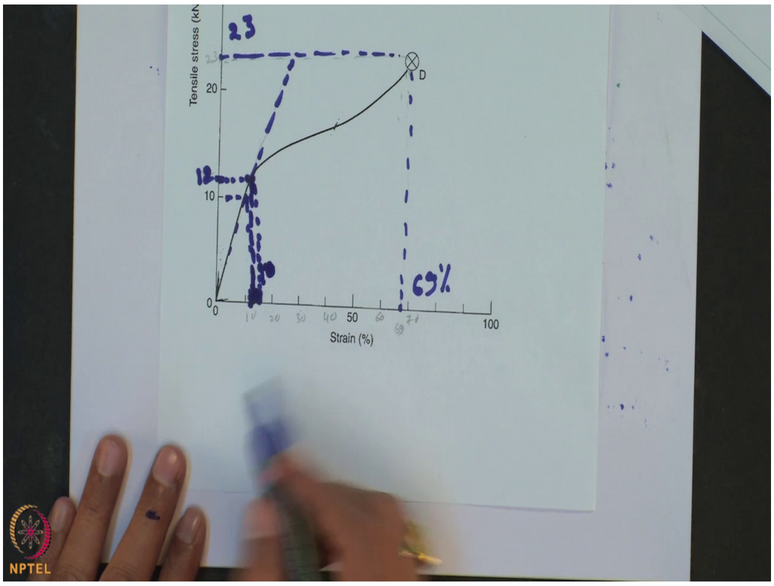

So, let us say this is the, this the non woven geotextile material whose tensile stress and strain curve is looks like this. And these material have some thickness and this material have some mass per unit area.

For example, this material is non woven heat bonded material and mass per unit area of this material is 135 gram per meter square. And thickness of this non woven heat bonded geotextile material is 0.33 millimeter. So, for the non woven geotextile material as it is shown the tensile stress bar stress strain relationship curve and from this curve we want to determine that what should be the strain, what should be the elongation, what should be the toughness and the modulus in this geotextile material.

So, first of all from this stress strain relationship curve; we want to determine what should be the strain value? So, here you see that maximum this strain value tensile stress value is about you can say this is about 23 kilo Newton per meter.

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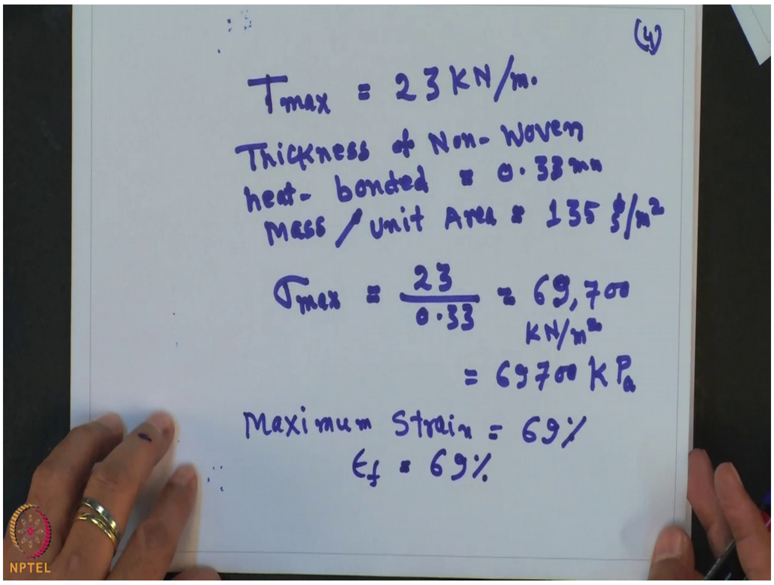

So, you can write that strength that mean maximum strength; that is T of maximum is equal to 23 kilo Newton per meter. And we know the thickness; thickness of non woven heat bonded; non woven heat bonded geotextile material thickness is about 0.33; 0.33 this is millimeter and also mass per unit area is 135 gram per meter square.

So, we have to determine that what should be the maximum stress? So, sigma of maximum will be equal to 23 this divided by the thickness is 0 point; 0.33. So, this will give you the value of maximum stress is 69700 I think kilo Newton per meter square or you can write this will be 69700 Pascal. So, what is the elongation or maximum strain value? So, if you can look here maximum this is a strain; so, maximum strain value is somewhere here.

So, this is let us say 50; so this is about epsilon f is about 69 percentage. So, this is 69 percentage. So, strain value let us say maximum strain; maximum strain is equal to 69 percentage. So, you can write epsilon f as a maximum strain is equal to 69 percentage. So, you know that maximum strain you have to determine toughness of geotextile material toughness.

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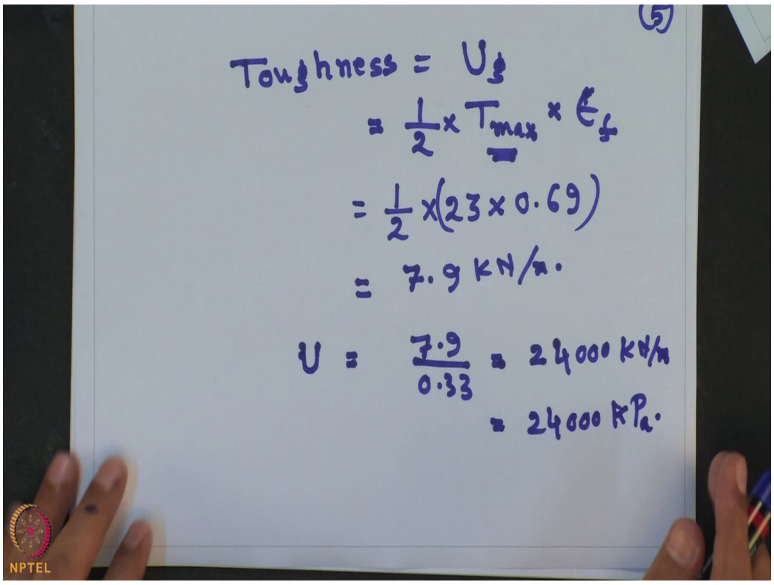

Toughness is designated as U ok; so, this U will be equal to half of T of maximum into epsilon f. Earlier we determined T max, which is 23 kilo Newton per meter, this is T max which is 23 kilo Newton per meter. So, we can write this is equal to half into 23 and the; this is the maximum strain epsilon f and epsilon f maximum strain is 69 percentage; so, we can write this is 69 percentage.

So, if you calculate the toughness also you can designated as f of g; toughness is equal to is about 7.9 kilo Newton per meter. So, we know that thickness of the geotextile material is 0.33; so we can write that toughness also in terms of kilo Newton per meter square for the thickness of 0.33; that means, U can be determined as 7.9 this divided by thickness is 0.33 is equal to 20; thing 24000 kilo Newton per meter or you can write 24000 kilo Pascal.

Now, we have to determine that what should be the modulus; that means, what should be the initial tangent modulus, which is initial slope. So, from this stress tensile stress strain curve of the geotextile material, you can determine what is modulus. So, you can draw the draw the tangent like this; this is the tangent and from this tangent, you can determine what should be the slope?

For example, that let us say that it is for the 10 percent strain value and the corresponding the strain value 10 or you can say the let us say for the 12 percent strain, for the 12 percent. Let us say strain this is stress value 12 percent stress and the corresponding strain value; let us say about let us say like this actually.

So, this is the stress value, this is the strain value let us say strain value is about 10 percentage. So, what I am trying to say if the from this curve if I take that stress value is about 12 kilo Newton per meter.

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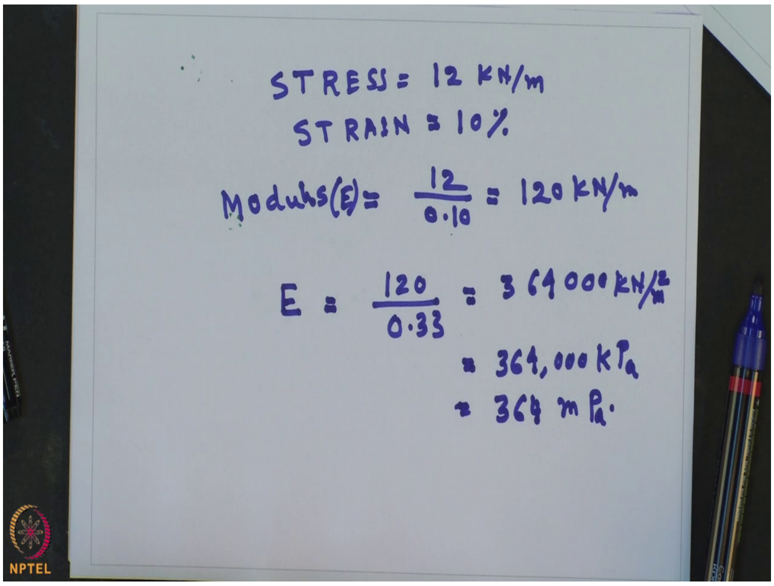

And corresponding strain value is equal to 10 percentage; so, modulus of geotextile material will be equal to 12 divided by 0.10. So, this will give you 120 kilo Newton per meter; so, from this curve basically I am getting that if this value is the 12 these value is the 12 and corresponding the strain value; let us say it is 10. So, that is why this stress value is 12 kilo Newton per meter, strain value is 10 percent then modulus will be 12 by 0.10 is 120 kilo Newton per meter.

Now, you know that thickness; thickness is 0.33 therefore, E; E can determined or this is you can say modulus as a E; E can be determined as 120 kilo Newton per meter square, this divide then why thickness is 0.33. So, this will give you 364000 this is kilo Newton per meter square or you can write 364000; this is kilo Pascal or you can write 364 mega Pascal ok. So, from the stress strain curve of the geotextile, you can determine different properties of the geosynthetics material that is initial tangent modulus second modulus and that what should be the, what should be the different types of the modulus or offset modulus etcetera.

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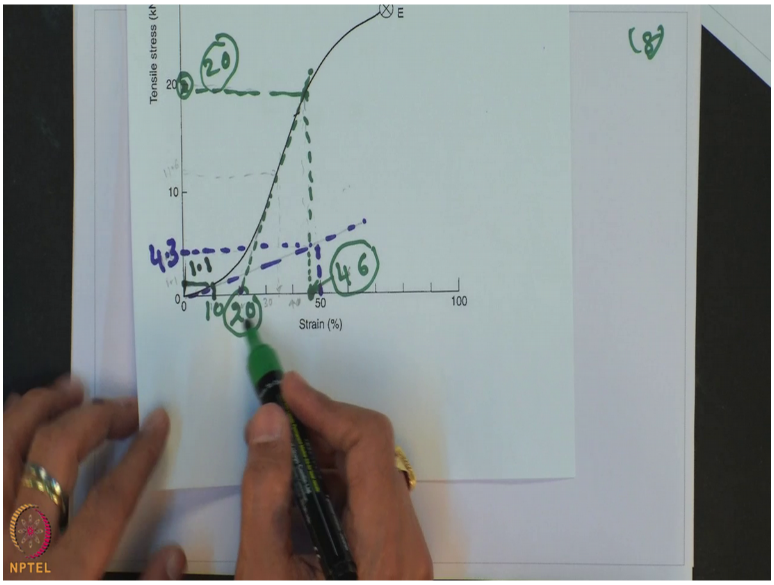

Now, I will give the another example for a non woven needle punched geotextile material. For example, this is the tensile stress and strain curve for the non woven needle punched geotextile material; this is non woven needle punched geotextile material and this material I say that it is non woven needle punched geotextile material.

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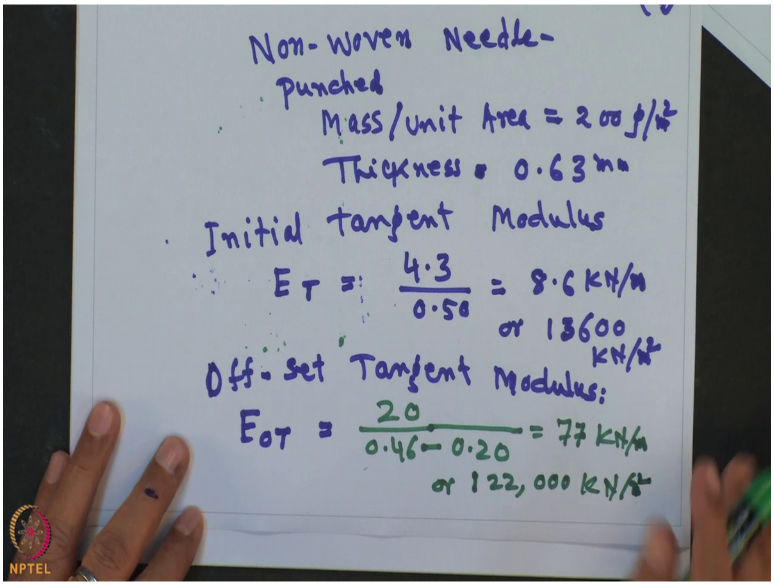

And this geotextile material let us say mass per unit area is equal to 200 gram per meter square and thickness is equal to 0.63 millimeter.

So, from this curve of the needle punched non woven geotextile material; we have to calculate that what will be the initial tangent modulus, what should be the offset tangent modulus and second modulus at 10 percent and 5 percentage of strain in kilo Newton per meter and kilo Newton per meter square or kilo Pascal; based on the initial thickness of the geotextile material is 0.63.

So first of all that, what should be the initial tangent modulus? So, initial tangent modulus that is designated at E of T; let us say that this is the initial tangent modulus. And for example, that this here this is the initial tangent modulus and let us say for the 50 percent strain value; 50 percent strain value that corresponding the stress let us say 4.3.

So, what will be the modulus value? Initial tangent modulus value; that means, 4.3 by 50 percent; that means, 4.3 divided by 0.50; so, this will give you 8.6 kilo Newton per meter or if you want to determine in terms of kilo Newton per meter square, then you know that what will be the thickness. And then you can determine in terms of the kilo Newton per meter square and that will be about 13600, this is kilo Newton per meter square.

And the next is that what will be the offset tangent modulus? So, offset tangent modulus is offset remember this offset tangent modulus which is designated at E OT offset tangent modulus. So, offset tangent modulus is if I draw a offset tangent modulus; so, for example that when the tensile stress is about 20 and the corresponding, the strain value will be let us say here is 46 and here it is 10. So, this is the 20, this is 46 and this is the 20 and this value is about 20 (Refer Time: 32:15) and this is the strain this, the offset modulus value; slope of this curve.

So, offset modulus E OT will be equal to 20 divided by 0.46 minus 0.20; so as I said that this is 20 and this is 46 and 0.46; 0.20. So, you can have the offset tangent modulus value is about 77 kilo Newton per meter or you know the thickness, so you can determine this as 122; 1 2 3 kilo Newton per meter square.

And you have to calculate the second modulus at 10 percent; let us say second modulus at 10 percent is E S 10.

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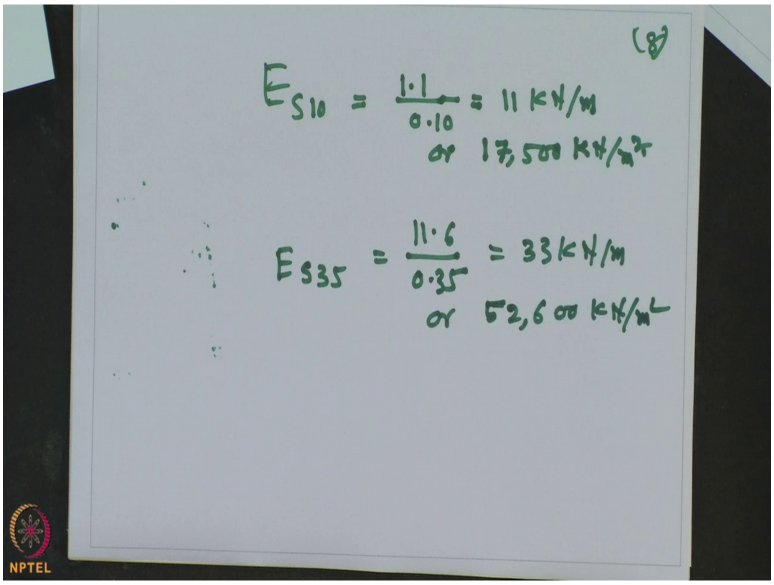

So, E S 10; so you can calculate the second modulus, second modulus E S 10 percent; that means, if you take for the 10 percent you have to determine. So, this is the 10 percent and corresponding the value let us say 1.1; so, E S 10 you can write 1.1 divided by 0.10 is equal to 11 kilo Newton per meter or you know the thickness. So, you can determine that in kilo Newton per meter square 17500 kilo Newton per meter square.

Similarly for the 35 percent strain, let us say this is the 50; let us say this is the 35 here. So, for the 35 percent and the stress value is let us say 11.6 kilo Newton per meter. So, for the 35 percent strain you can write E S 35 is equal to 11.6 divided by 0.35 because this is the 35 here, this is 35 here and this is corresponding stress value 11.6 and 35.33; this will be 33 kilo Newton per meter or you can say 52600 kilo Newton per meter square.

So, from the stress strain curve you can determine the initial tangent modulus, second modulus or strain at any; stress at any strain value modulus at any strain value, it may be 10 percent, 35 percent, 25 percent etcetera.

Thank you.