Geosynthetics Engineering: In Theory and Practices
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Module - 02
An Overview of Geosynthetics Part III
Lecture – 08

Welcome, to Lecture 8, my name is Professor J N Mandal, Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai, India. The name of the course Geo synthetics Engineering In theory and Practice, this is Module 2, Lecture 8, An Overview of Geo synthetics.

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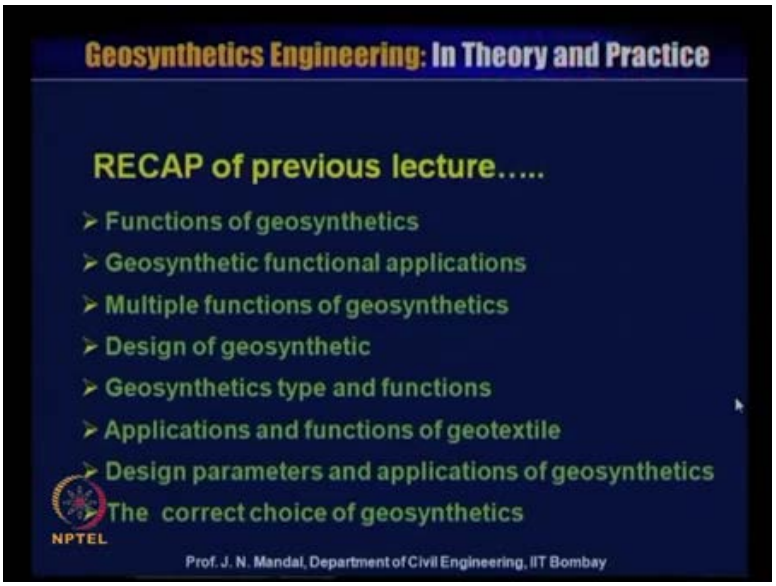

I will, now focus the recap of the previous lecture we will cover function of geo synthetics, then geo synthetics functional application, multiply function of geo synthetics, design of geo synthetic, geo synthetic type and function, application and function of geo textile, design parameter and application of geo synthetics and the correct choice of geo synthetics.

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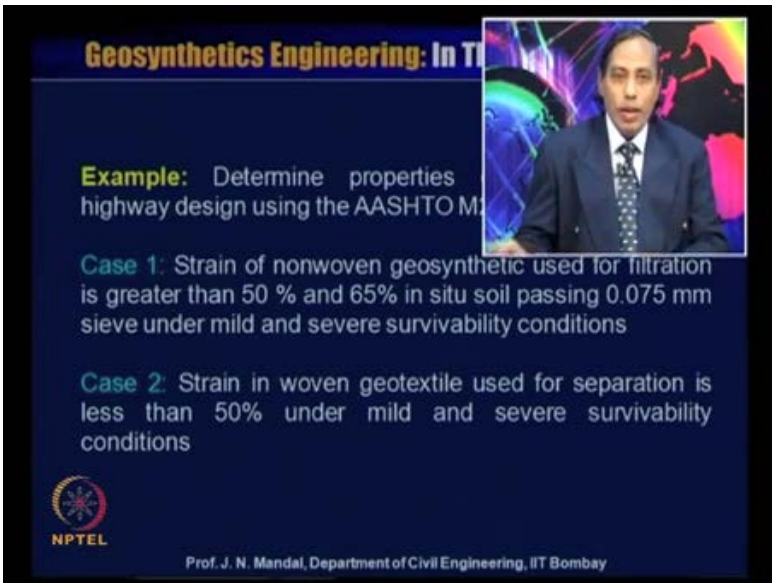

Now, I will give one example that is determine the properties of geo synthetics for highway design using the AASHTO M 2 8 8 table, first of all we should know the use of this AASHTO M 2 8 8 table. Case 1, strain of nonwoven geo synthetics used for filtration is greater, than 50 percent and 65 percent in situ soil passing 0.0075 millimeter, severe under mild and severe survivability condition; that means, soil passing through 0.075 millimeter slip, under mild and severe survivability condition.

Case 2, stain in woven geo textile used for separation is less than 50 percent under mild and severe survivability condition. So, in this problem first of all case 1, we check that chain of NANO geo synthetics material is greater than 50 percent and 65 percentage and it is under mild and severe survivability condition. So, you remember that we will use that it is greater than 50 percent and 65 percentage and under the mild and severe survivability condition. Similarly case 2, for the stain in woven geo textile used for separation, it is less than 50 percent and under mild and severe survivability condition.

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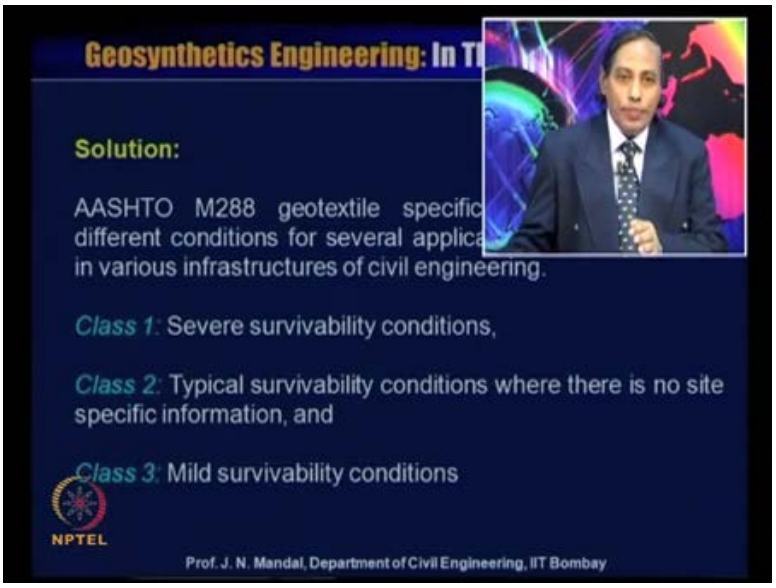

Now, I will go for the solution, so the AASHTO M 2 8 8 geo textile specification provide three different condition for several application of geo synthetics in various infrastructure of civil engineering. case 1, severe survivability condition, case 2 typical survivability condition, where there is no site specific information and case 3 mild survivability condition.

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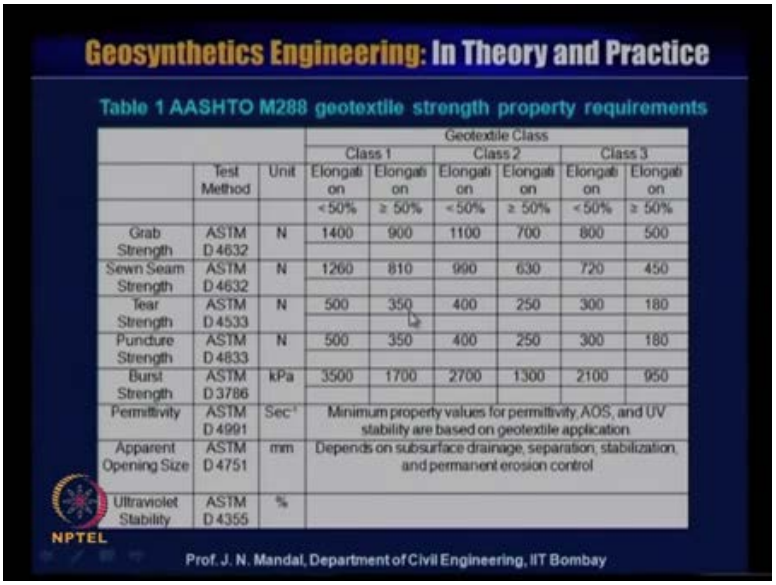

Now, look at this table AASHTO M 288 geo textile strength property requirement, what strength are required there are classes 1, class 2 and class 3, this is all geo textile class

and these are the property we require, that is grab strength as per ASTM D 4632, sewn seam strength as per ASTM D 4633, tear strength ASTM D 4533, puncture strength ASTM D 4833, burst straight ASTM D 3786, permittivity ASTM D 4991, apparent opening size ASTM D 4751, ultraviolet stability ASTM D 43 5.

And the class 1 you can see here that elongation thus less than 50 percent and elongation greater than equal to 50 percent, if it is a less than 50 percent. So, this value grab strength value 1400 Newton, sewn seam value 1260 Newton, tear strength value 500 Newton, puncture strength 500 Newton and burst strength 3500 and the 2 also calculate what will be the permittivity apparent opening size and ultraviolet stability.

Now, if it is a greater than 50, these are the value 900, 810, 350, 350 and 1700, similarly for class 2, if it is a less than 50 percent, if it is a greater than equal to 50 percent these are the all values. And similarly class 3, if it is a less than 50 percent and greater than equal to 50 percent then you can have all these values. Now, you can see here very carefully class 1, means severe survivability condition and class 3 is mild survivability conditions, so you remember which is severe case in class 1 and mild is class 3.

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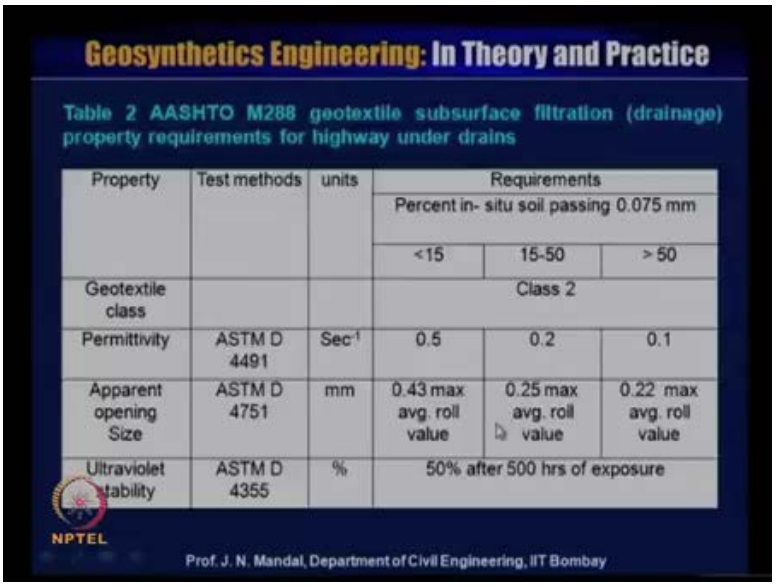

Next, is the table 2 AASHTO M 288 geo textile subsurface filtration, drainage property requirement for highway under drain, so here the geo textile permittivity as per ASTM D 4491 in unit is per second. And you can see that requirement percent in situ soil passing 0.075 millimeter, is very less than 15 to 50 or greater than 50 and case of class 2

permittivity as per ASTM D 4491, this value is 0.5, this if it is lies between 15 to 50 then 0.2, if it is a greater than 50 then it is a 0.1.

And the apparent opening size of geo textile ASTM D 4751, this unit is millimeter 0.43 maximum average roll value and 0.25 maximum average roll value and 0.22 maximum average roll value. And ultraviolet stability also very important this is as per test method ASTM D 4355 and that, express in percentage unit this is 50 percentage after 500 hour of exposure.

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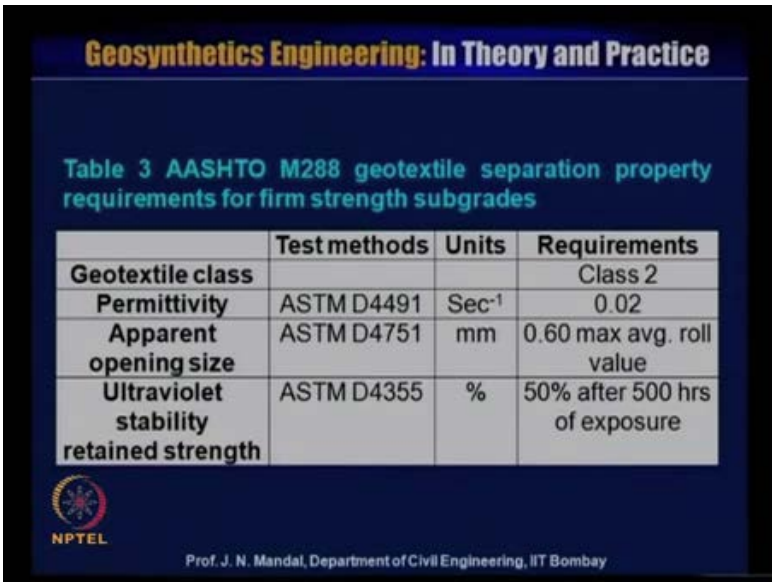

The next table 3, this is AASHTO M 288 geo textile separation property requirement firm strength sub grade, now geo textile may be permittivity test method ASTM D 491 and class 2, this is class 2. So, requirement 0.02 apparent opening size ASTM D 4 751 and this is in millimeter unit and requirement 0.6 0 maximum average roll value, ultraviolet stability retain strength ASTM D 4355, that unit percentage that is 50 percent after 500 hour of exposure. So, it depend up on what class, this is class 2 for us this also class 2, similarly you can have the there are many AASTHO table specification.

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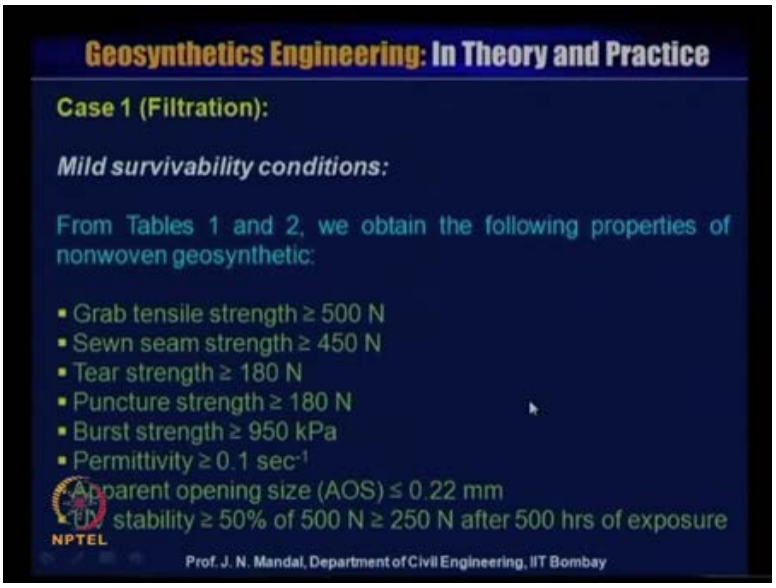

Now, we are solve the case 1, problem that is filtration and condition is the mild survivability, so mean time determine the property from table 1 and 2. So, we can obtain the following property for nonwoven geo textile material, that is grab tensile strength is greater than equal to 500 Newton, sewn seam strength is greater than equal to 450 Newton tear strength greater than equal to 180 Newton, puncture strength greater than equal to 180 Newton, burst strength greater than equal to 950 kilo Pascal, permittivity greater than equal to 0.1 per second, apparent opening size.

Which is say a o s less than equal to 0.22 millimeter and u v stability greater than 50 percentage of the 500, this grab strength value that is greater than equal to 250 Newton after 500 hour of exposure. So, we can see these table 1 and 2, you can see this is the table 1 and because it is a mild, so we and the elongation is greater than 50 percentage. So, we are considering these value, these are the value grab strength, then sewn seam strength, then the tear strength, then the puncture strength and also the burst strength and this is for strength property of the requirement.

Next is that, what will be the permittivity apparent opening size and the ultraviolet stability, as this is greater than 50, because 65 percentage greater than 50, so is greater than 50. So, permittivity is 0.1 per second and the apparent opening size 0.22 maximum average roll value and ultraviolet stability ASTM D 4 3 5 5, that is 50 percent after 500 hour of exposure. So, this way we have calculated and so that what will be the property

of the geo synthetics material requirement and this is for mild survivability condition.

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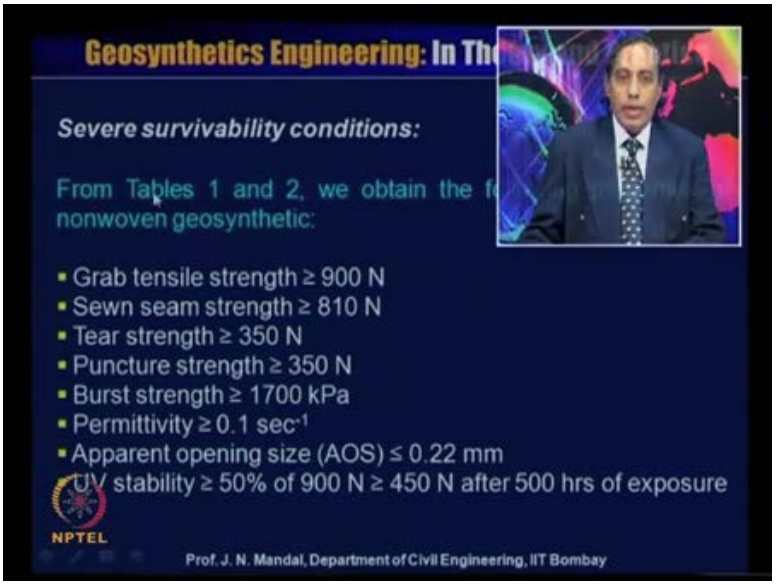

Next, if we do the severe survivability condition that means, we will follow up table 1 and table 2. So, from this table 1, we can obtain grab tensile strength greater than equal to 900 Newton, sewn seam strength greater than equal to 810 Newton, tear strength greater than equal to 350 Newton, puncture strength greater than equal to 350 Newton, burst strength greater than equal to 1700 kilo Pascal.

And from the table 2, we can have permittivity greater than equal to 0.1 per second, apparent opening size that is a o s less than equal to 0.22 millimeter and u v stability is greater than equal to 50 percentage of 900 Newton. Because, this grab strength value is 900, so 50 percent of the 900, Newton that is greater than equal to 450 Newton after 500 hour of exposure.

So, you can obtain this value from the table 1, I say that this is table 1 and this is in severe condition. So, and this value is greater than 50 percentage, because greater than 50 percent say. So, we have taken all these value, that is grab strength, sewn strength, tear strength, puncture strength, burst strength etcetera and also for permittivity, we have taken that this is 0.1 and 0.22, of maximum average roll value. So, this we have solved this problem and this is for severe survivability condition this is case 1.

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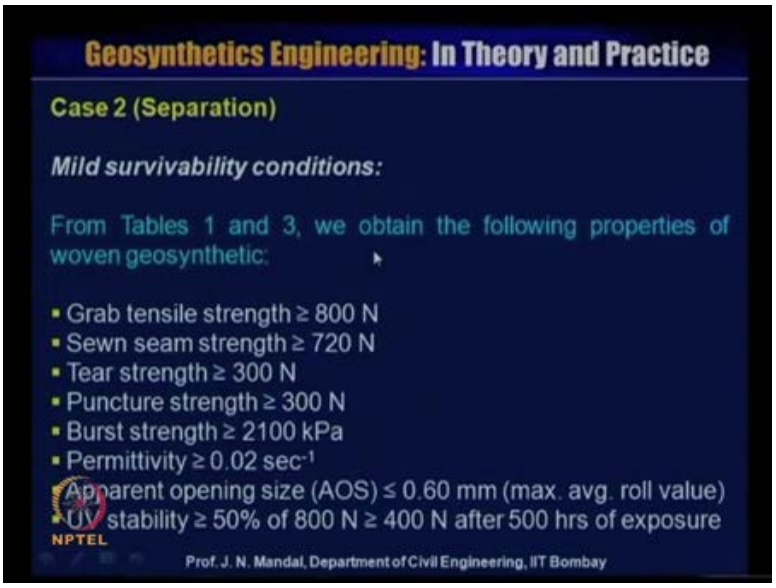

Now, in this case 2 separation and this is mild survivability condition, so for the mild survivability condition. And from the table 1 and 3, we obtain the following property of woven geo synthetic material, that mean grab strength is greater than equal to 800 Newton, sewn seam strength is greater than equal to 720 Newton, tear strength greater than equal to 300 Newton, puncture strength greater than equal to 300 Newton, burst strength greater than equal to 2100 kilo Pascal, permittivity greater than equal to 0.02 Pascal again, apparent opening size is less than 0.60 millimeter, that is maximum average roll value and u v stability 50 percentage of grab strength, that is 800 Newton that mean greater than 400 Newton after 500 hour of exposure.

Because, this is a mild survivability condition remember mild survivability condition, so grab strength, we can say from table 1 and 3 you can see table 1 and 3. Because, it is it is it is the it is the mild, so this will be the class 3 and it is also less than 5, that is why we have taken this value. And similarly for this other value that is working with the property for the permittivity that is 0.02 and the apparent opening size 0.6 max average roll value and ultraviolet stability retain strength, that is 50 percent after 500 hour of exposure. So, this is case 2, we talk about this separation and this is a mild survivability condition

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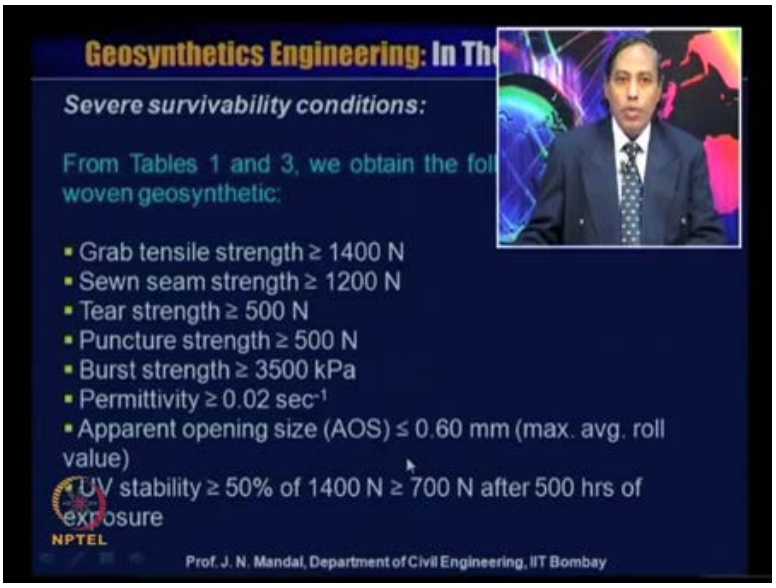

Next, is the severe survivability condition, so grab strength greater than equal to 1400 Newton, sewn seam strength greater than equal to 1200 Newton, tear strength greater than equal to 500 Newton, puncture strength greater than equal to 500 Newton, burst strength greater than equal to 3500 kilo Pascal, permittivity greater than equal to 0.02 per second, apparent opening size a o s less than equal to 0.6 millimeter maximum average roll value.

And u v stability greater than 50 percent of the grab tensile strength value, that is 1400 Newton is equal to greater than 700 Newton, after 500 hour of exposure. So, you can have this value from the table 1 and 3, this is in severe condition, so this is the severe condition we are taking this value for all grab strength, sewn strength and puncture strength, burst strength and this value from table 3, what will be the permittivity, what should be the apparent opening size, and what will be the ultraviolet stability of the retained strength, so you are having these values, so this is way we solve this problem. using the ASTRO specification.

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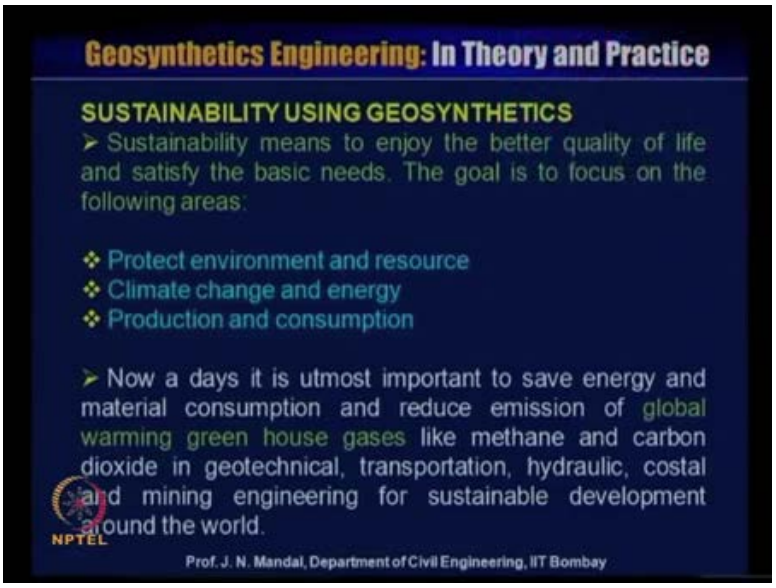

Next we will talk about the sustainability using geo synthetics material and why the question, that sustainability. Because, the environmental sustainability of the economy growth, how the economy can grow using the geo synthetic system wanted the meet that essential requirement, we require drinking water, we require sanitation, we require health care. So, how we can solve this kind of the problem and how, we can elevate the property is to in a sustainable manner and also ensure that effective use of the natural resources. So, you have to be taken care for, the natural resources and how renewable energy can be also that, use how we can ((Refer Time: 19:01)) development can stimulate the economic even, that we can create the employee, we can stand in the kinetic residency.

We can also go for the green business, what kind of the green business such as generate the renewable energy and the green product. And also you can produce the different types of environmental friendly construction material, which we can produce from the waste material and you can make use of this and also sustainable agriculture, base live jute if you go the construction, for the road and you can go the mangrove fruits and you can make a ((Refer Time: 19:55)) and also in flower.

So, it is always you can sustain yourself, you can renew how we can generate the money and people can generate and they, can sustain also environmental challenge can put constrained on the attention of the development goal. So, what is that sustainable infrastructure development need up to day, so how the sustainability is in geo synthetics

what do you mean by sustainability. So, sustainability means to enjoy the better quality of life and satisfy the basic needs, the goal is to focus on the following area, you need protect the environment and the resources climate change and energy production and consumption.

Now, a days it is utmost important to save energy and material consumption and reduce the emission of global warming, green house gases like methane, carbon dioxide in geotechnical, transportation, hydraulic, costal and mining engineering for sustainable development around the world. So, we need them to save the energy.

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So, sustainable development is not only saving energy and the material, but also protect the natural resources, economy and society worldwide, why recent model development is not sustainable. Because, we are living beyond our means.

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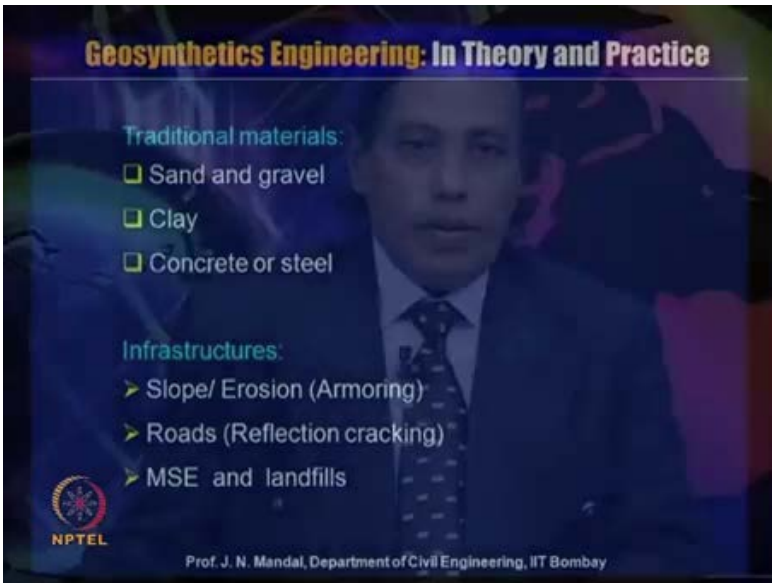

So, what we use in the traditional material we use huge quantity of sand and gravel for different infrastructure application, we use clay, we use huge quantity of concrete and the steel. And we use these kind of the traditional material in different infrastructure, I am just showing it here some of the infrastructure and how the geo synthetics can help to reduce the energy, how we can save the money, how we can save the time, how we can make use of the sustainable manner. So, here focusing here only infrastructure life slope and erosion like armoring roads reflection cracking and mechanical stabilized earth wall, that is m s e and the landfill.

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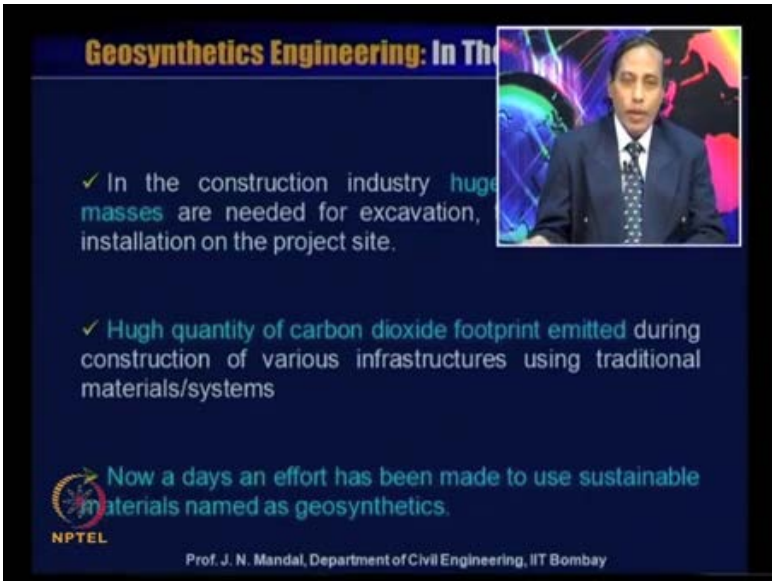

So, in the construction industry huge quantity of soil masses are needed for excavation transportation and installation on the project site, even though huge quantity we have to excavate and they need transport. And then you are imputing to the installation site either it is filling up or any other purpose or huge quantity of carbon dioxide footprint emitted during the construction of various infrastructure using traditional material or system.

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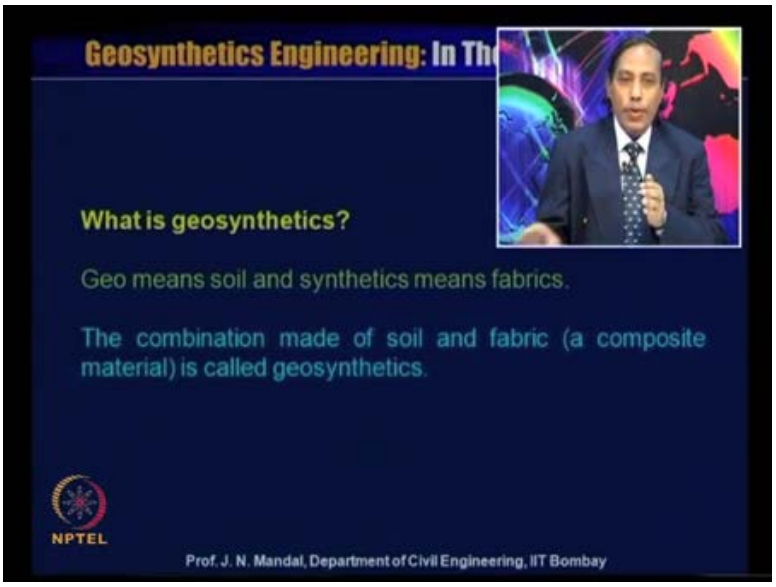

Now, a day an effort has been made to use sustainable material named as geo synthetics, now question comes what is geo synthetics, very simple definition of geo synthetics means geo means soil synthetics means fabric that means, the combination made of soil and fabric that is a composite material is called geo synthetics.

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Now, how can you compare the geo synthetics with the traditional material, you can see we use huge quantity of the steel and the concrete, for the construction of various infrastructure in India and around the world. So, alternative to this traditional material we can use the geo grid material, so both the material will act as a reinforcement, so we talk about earlier the design is based on the reinforcement function.

So, instead of using the steel concrete, so geo grid can be used as a reinforcement for example, we wanted to construct a reinforce concrete between a wall. So, we use huge quantity of the steel, cement and alternative to that we can simply use the geo grid material and soil as a backfill material. So, we can save lot of money and also time also in terms of energy, so that how the you can save the energy, how it is sustainable manner we can construct the different types of the infrastructure.

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Next, in the drainage function most of the cases, we use the gravel, sand as a drainage material that is the traditional material, we use in the different project gravel sand as a drainage material. And this thickness also vary 400, 500 millimeter kind of the thickness. So, we need to transport that all kind of the material to the project site, so you have to spend lot of money for this, you have to excavate you have to break you have to make the proper gradation.

So, alternative to the traditional material like gravel and the sand, we can use the prefabricated geo synthetics material like geo net and the geo composite and this material is very high flow capacity. So, it can solve the drainage problem it is also economical and it is also column key. So, we can use this kind of the material like geo net and geo composite alternative to the sand and gravel for the drainage structure.

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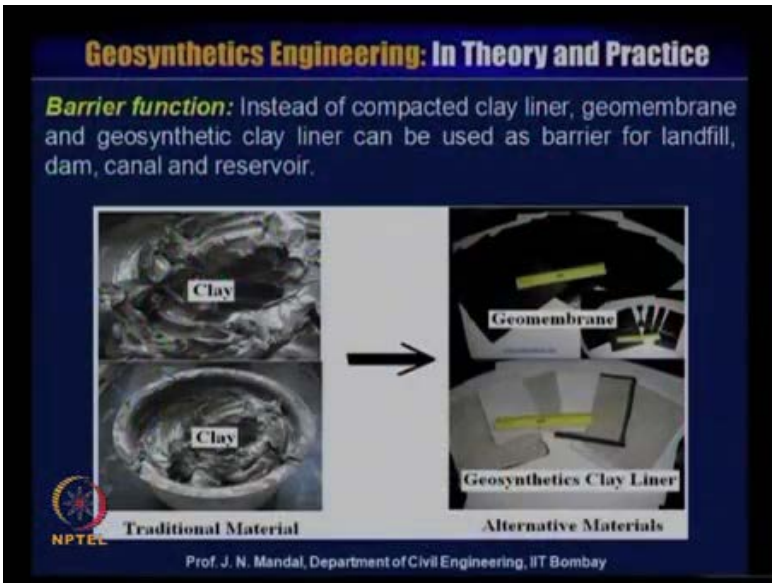

So, this is the second the function as a drainage barrier function, you can see that huge quantity of clay, so instead of compacted clay liner you can use the geo membrane and geo synthetic clay liner can be used as a barrier for example, we use in the landfill dam ,canal, reservoir as I mention that if we if we construct a landfill. So, traditional material we use huge quantity of clay and compacted it, it varies from 400 millimeter to 1500 millimeter, alternative to that kind of the thickness of the compacted clay liner.

So, we can simply use geo membrane or geo synthetics clay liner, this is also impermeable material and geo membrane, which thickness may be 100 0.5 millimeter to 2 millimeter 0.75 millimeter or 2.5 millimeter. So, you can think compare in terms of the thickness of compacted, clay liner to the thickness of the geo membrane. In case of alternative to the geo membrane you can use also geo synthetics clay liner, which is made of bentonite and laminated with the woven and non woven geo textile material and whose thickness may be 4.5 millimeter or 5.5 millimeter. And whenever it geo synthetic clay liner come in contact with water, it soil and it act as a barrier, so you can use this kind of the product and play huge quantity of bentonite also available in India. So, this material can act as a barrier, so barrier is one of the function.

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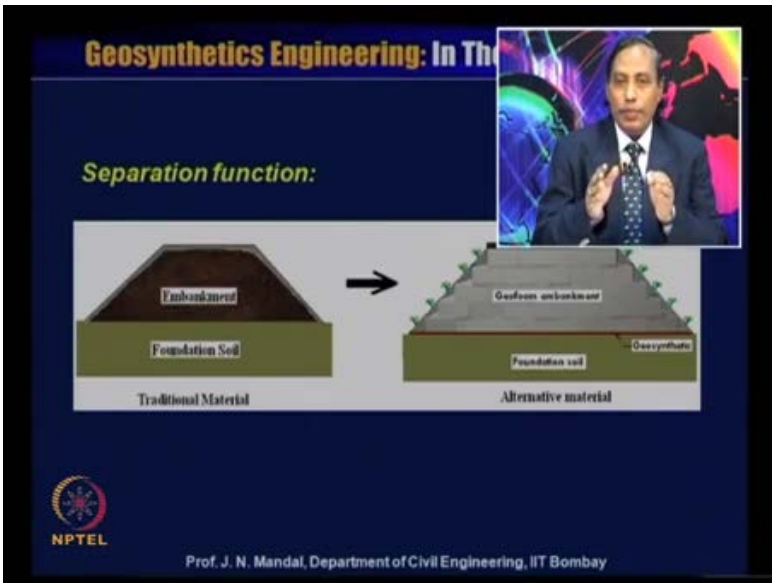

Now, look at this slide as a separation function you can say traditional method, you have on the top of the foundation soil you are constructing the embankment, sometimes you go for the improvement of the ground by using the sanding, pilings all any stabilization system or any stone column system. So, you do not need if you add of the alternative system, you fill up with a good quality of the gradient material, for the construction of embankment in the traditional material, alternative to this system, you can see the right inside that you can play say one layer of geo synthetic material.

And on the top of that you can place the geo foam you can have it in the form of block or in the form of cellular type of the geo foam and you can place, it is the very super light material is the simply place it. And on the subside you can provide with the geo membrane and the you can fill up with the soil, you can say grass can grow and on the top of that load you can provided the asphalt overlay.

So, it is a very simple construction you do not need any kind of the excavation and the design is very simple and the design, also is based on the density of the geo foam. And also what will be the thickness of the geo foam and what will be their different mechanical and the chemical and also the environmental property, here the geo foam act as a separation function.

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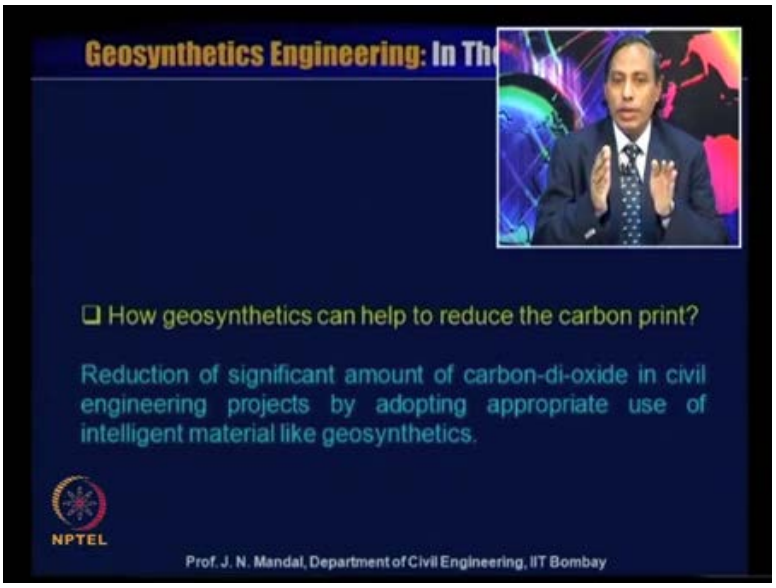

So, how geo synthetics can help to reduce the carbon print, this is very important to us we are talking about, so many sustainable renewable energy how we can survive in this art. So, how we can reduction of significant amount of carbon dioxide, in civil engineering project by adopting appropriate use of intelligent material like geo synthetics.

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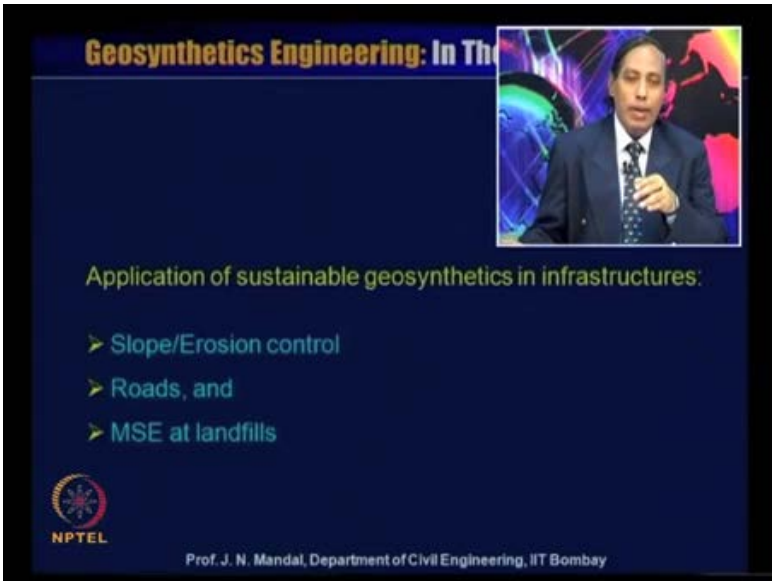

So, application of sustainable geo synthetics in infrastructure, I will show you some slide where we can see, that how we can use, how we can save the energy for example, that in

case of slope or erosion control related problem, if it is a road and mechanically stabilized wall at landfills slide.

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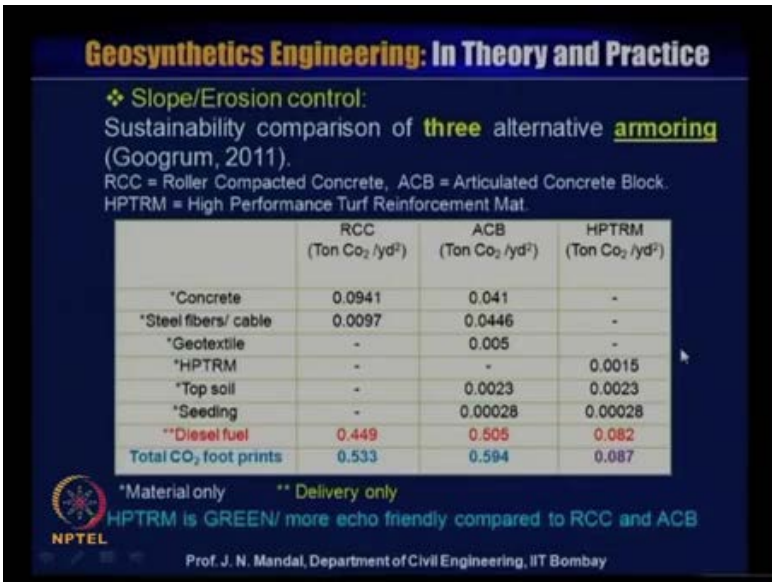

This is slope or erosion control problem, this is sustainability comparison for the three alternative armoring this is googrum 2001, here you can see that for the slope or erosion control, you may go for the roller compaction concrete this is mud is going on or you can go for the articulated concrete block, which is called the a c b and this is the alternative that is h p t r m, which we call the high performance turf reinforcement mat.

So, we can see that this r c c, a c b or h p t r m that is ton carbon dioxide per years, so we can see that concrete, this is only material only concrete if you per r c c you can say 0.0 9 4 1 ton carbon dioxide per year, a c b articulated concrete block is 0.041 here, you do not need any concrete steel fiber or cable for r c c, it is 0.0097 ton carbon dioxide per years.

And for articulated concrete block or a c b 0.0446 and we do not need for h p t r m, if you use geo textile, it is 0.005 ton carbon dioxide per year, h p t r m you do not need, h p t r m you need only 0.0015 ton carbon dioxide per year, top soil that you require for a c b 0.0023 and also for h p t r m you require 0.0023 and seeding you require for a c b 0.00028, this is also for h p t r m 0.00028.

So, diesel fuel that is delivery only, so if you deliver only diesel fuel your for r c c, that is roller compacted concrete you required 0.449 ton carbon dioxide per years for the a c b

articulated concrete block, you require 0.505 on the other hand for the h p t r m or a high performance turf reinforcement mat you require only 0.082 ton carbon dioxide per year. So, total carbon dioxide footprint in case of r c c 0.533 ton carbon dioxide per year.

And a c b articulated concrete block you require 0.594 ton carbon dioxide per years and for h p t r m that mean, high performance turf reinforcement mat you require only 0.087 ton carbon dioxide per year. So, what we have observed here that, h p t r m or the high performance turf reinforcement, mat is green and more echo friendly compare to the roller compacted, concrete or the articulated concrete block.

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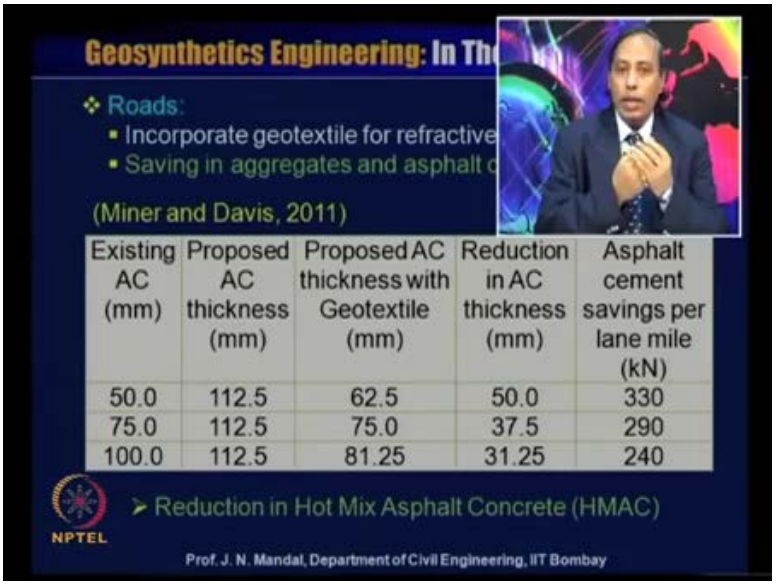

So, next if we considered road projects you have to incorporate a geo textile for refractive cracking, so you can saving the aggregate and asphalt concrete this is by miner and Davis 2011, this is existing a c that is your 50 millimeter 75 millimeter and 100 millimeter. And then proposed a c thickness millimeter 100 and 12.5 millimeter, 100 and 12.5 millimeter, 100 and 12.5 millimeter, and 100 and 12.5 millimeter, every year you keep on putting the asphalt level layer on the existing a c.

So, if we use that geo synthetics material, so proposed a c thickness with geo textile, we can see how we can reduce, that is 62.5 millimeter, 75 millimeter 81.25 millimeter, if you subtract from this to this you can have this. So, reduction in a c thickness with the this minus, this is 50 and this minus, this is 37.5 and this minus, this is 31.25. So, how the thickness can be reduced drastically and equally you look at the asphalt cement saving,

per lane mile in kilo Newton, this is a very expensive asphalt cement saving. So, you can see that in here you can say 330 kilo Newton 290 and 240.

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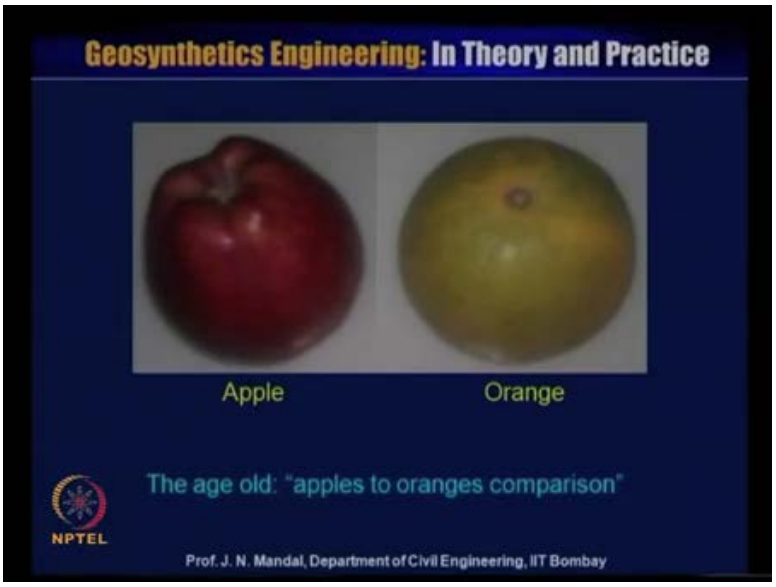

So, reduction in hot mix asphalt concrete which you call the h m a c, so you can save lot of energy can save, lot of its like a apple to orange, this is a age old apple to orange comparison.

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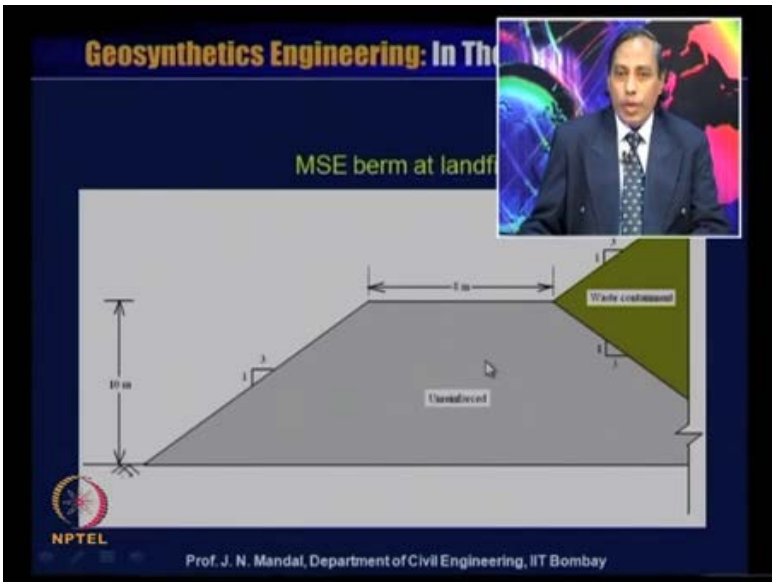

Now we will we will discuss this m s e berm at the landfill, so here is the landfill that all waste containment, it as a slope there are 3 vertical, 1 vertical to 3 horizontal and this is 8

meter heater, this 3 horizontal to 1 vertical and height is about the 10 meter and this, is all unreinforced and this is 1 vertical to 3 horizontal. So, how you can minimize this how we can save the energy.

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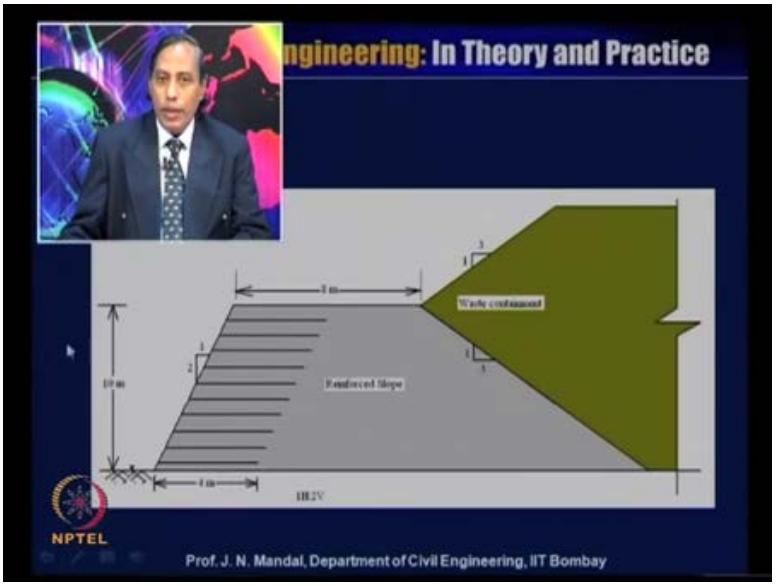

So, you can provide if the multilayer of the reinforcement and also, you can reduce the slope vertical to horizontal is 2 is to 1. So, you can minimize and this also we can see this is the 1 vertical to 3 horizontal, this is 1 vertical to 3 horizontal.

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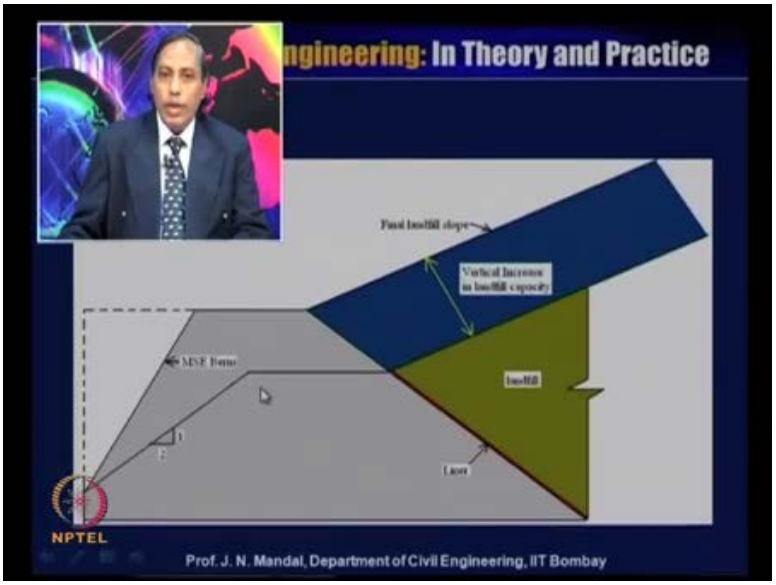

So, we can construct even then you can construct this reinforced wall here, so you can

save this land, now if you wanted to increase multiple increase in the land fill capacity. So, we can increase the landfill capacity by introducing this geo synthetic material, so you can make a berm mechanically stabilized earth berm here and you can provide if this is a landfill.

So, we can provide this liner as a geo membrane, liner impermeable material and these can also increase that, mean vertical increase in the that, will increase also the landfill capacity. So, you have are avoiding the space to fill up the all kind, of the waste material into the landfill by vertical increase in the landfill system. So, you can increase the landfill and you, can provide here with the mechanically stabilized earth berm system.

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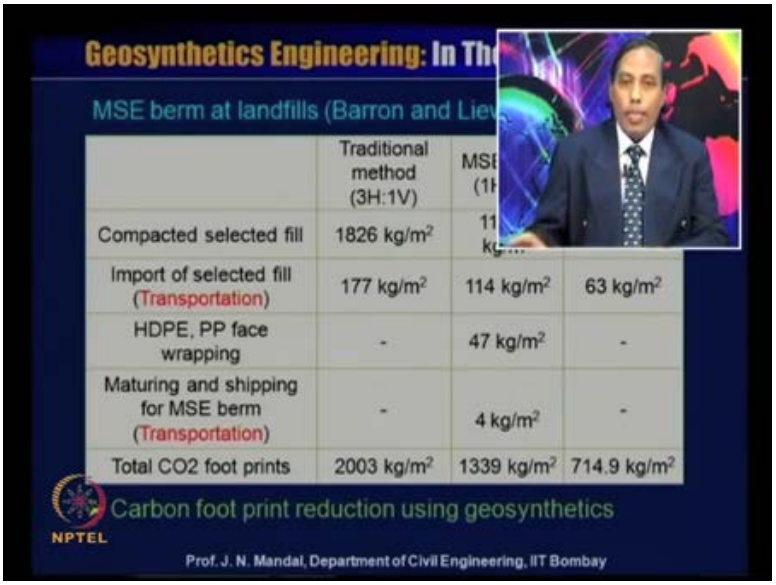

So, we can reduce that reduce the slope or you can excavate you can make steeper slope or you can make a even in 90 degree, that is reinforced soil retaining wall. Now, you can see this then mechanically stabilized earth berm at landfill, this is a Barron and Liew 2011. And this is the traditional method that is 3 horizontal to 1 vertical we can see mechanically stabilized earth berm this is 1 horizontal to 2 vertical then how much you are saving.

So, if you use compacted selected fill, so traditional method you require 1826 k g per meter square, if you use mechanical stabilized earth berm is 1 horizontal, 2 vertical your requirement is 1174 0.1 k g per meter square; that means, you are saving 651.9 k g per meter square. Now, look at the transportation that means, you require import of the

selected fill all the time you cannot have the material on the spot.

So, you require the import of the selected fill that, you require transportation and that for traditional material, you require 177 k g per meter square whereas, in case of m s e Berm with 1 horizontal 2 vertical, you require 114 kg per meter square. So, you can see the saving is about 63 k g per meter square or if you use high density polyethylene that means, h d p e or polypropylene face wrapping, then for the mechanical stabilized earth berm,1 horizontal to 2 vertical is required only 47 k g per meter square.

If we use maturing and the shipping for mechanically stabilized earth berm sometimes, you required to transport this kind of the material on the site that means, high density polyethylene or polypropylene or the geo grid material or the geo textile material on the site, you require transportation this is very light material compared to the soil. So, this is for mechanically stabilized earth berm, you require only 4 k g per meter square.

So, look at this what will be the total carbon dioxide foot print, if you adopt the traditional method if you adopt traditional method, you can see the total carbon dioxide foot print is 2003 k g per meter square, why that if you use mechanically stabilized earth berm with the 1 horizontal to 2 vertical and it is 1339 k g per meter square. So, you are saving about 7114.9 k g per meter square, you look at that how the carbon foot print reduce, when you use the geo synthetic material.

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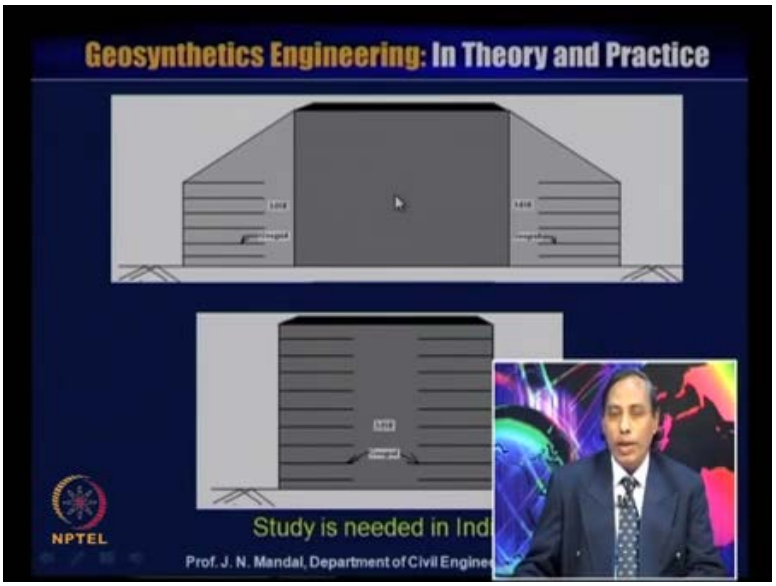

So, this is some of the example I have just addressed that how these in case of the erosion control or the slope, in case of mechanically reinforced earth wall or the landfill etcetera. Now, this is one study I just mention the most of the cases that sometimes, we find we want to construct these reinforced soil retaining wall, mechanically stabilized enforce retaining wall and the both side of the highway, we provide with the geo grid material and construct this mechanically stabilized earth wall.

But, sometimes this design is slightly different, they extend it and then fill up with the filling material and then they put the multilayer of reinforcement here or here. But, if you think about the material, collection, dumping, compaction and with respect to this structure. So, this is very typical structure these they say that this will be the much more cheaper. Because, this number of the reinforcement layer can be reduced, but if you think in terms of the energy or carbon dioxide foot print. So, it seems to be something different, so that I think that some study is needed in India in this leaded area.

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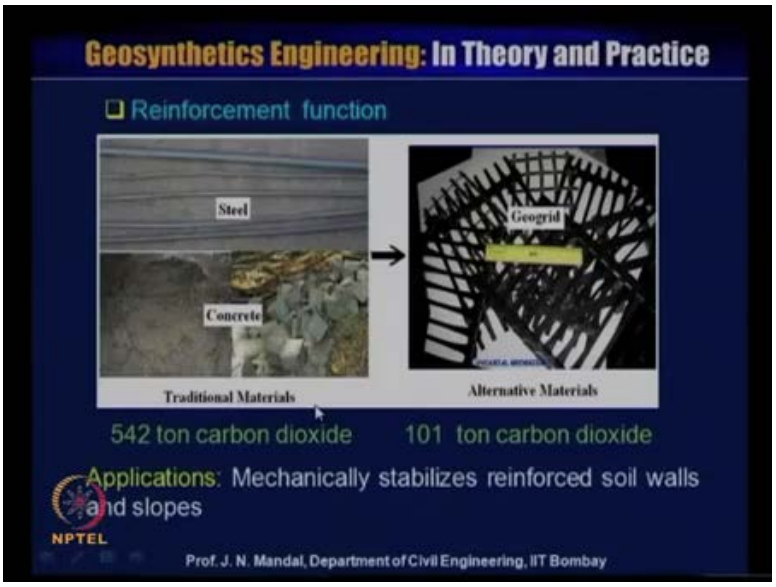

Now, I said that how this material traditional material, which act as a enforcement materials steel and concrete alternative the geo grid material, you can see that 542 tons carbon dioxide, if you use this kind of the material steel and concrete whereas, if you use the geo grid material, you can see 101 ton carbon dioxide. So, these most of the time we using up our many mechanical stabilized reinforced soil wall and the slope, so you think that, if you adopt this conventional method what will be the quantity of carbon dioxide

542 ton on the other hand, if you adopt the alternative material like geo grid. So, your carbon dioxide is 101 ton.

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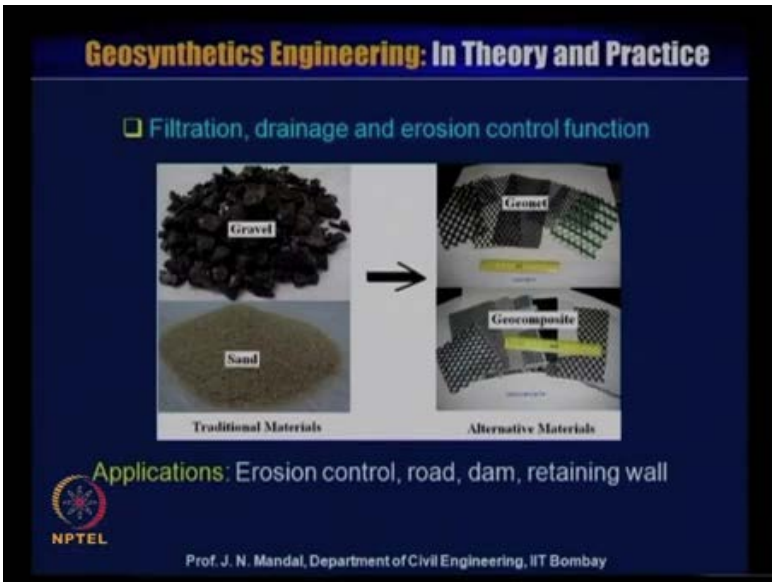

So, we can save and also for the filtration drainage and erosion control function, we use the most of the time gravel ((Refer Time: 48:00)) sand alternative to the alternative method is geo net and the geo composite material. So, these erosion control road dam and also, retaining wall we can adopt for the alternative system and it can be reduce the carbon foot print.

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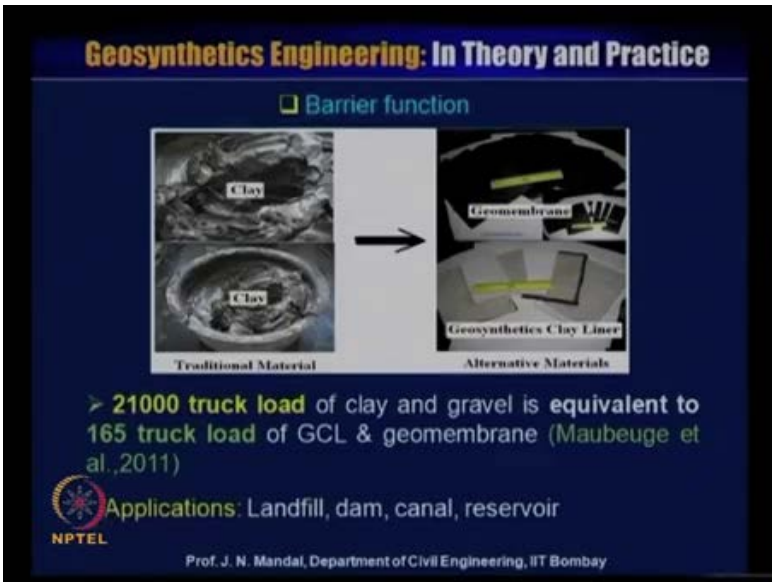

Next in barrier function we use clay and the alternative the geo membrane or the geo synthetics clay liner, we can see here to 21000 truck load of clay and gravel is equivalent to all only 165 truck load of geo synthetic clay liner or and geo membrane, this is Maubeuge e t a l 2001, you think about that for example, if you want to construct a landfill. And as a barrier any place you go for the dam construction, you go for the canal construction, you go for the reservoir construction, you think that 21000 truck load, you require of clay.

And the gravel for the construction with the conventional material on the other hand if you simply, use the 165 truck load of geo synthetic clay liner and geo membrane. So, you can save lot of energy, so you can reduce, huge quantity of carbon foot print and these geo membrane is very thin. As I say 0.751 0.5 or 2 millimeter or the 2.5 millimeter and it is very easy, to transport it is very lighten material. So, these kind of the application barrier as a barrier function, in the case of the landfill dam canal and the reservoir. So, also separation function instead of the conventional material, so we can add up the geo foam material, which will be the very lighter and also we can save lot of carbon oxide.

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So, we say transportation waste power and infrastructure are mainly the reason for carbon emission, if we do not control or take care of carbon foot print, our life will be miserable and unsuitable for living in the planet in foreseeable future. Every human has to be cautious about their, way of living in the planet by 2030, it is necessary to

decarbonize the world by 90 percent for making the planet sustainable. Sustainability is like a fest f e s t, that is financial environmental social and transparency, so we need reduced waste and emission save energy go green and adopt green technology.

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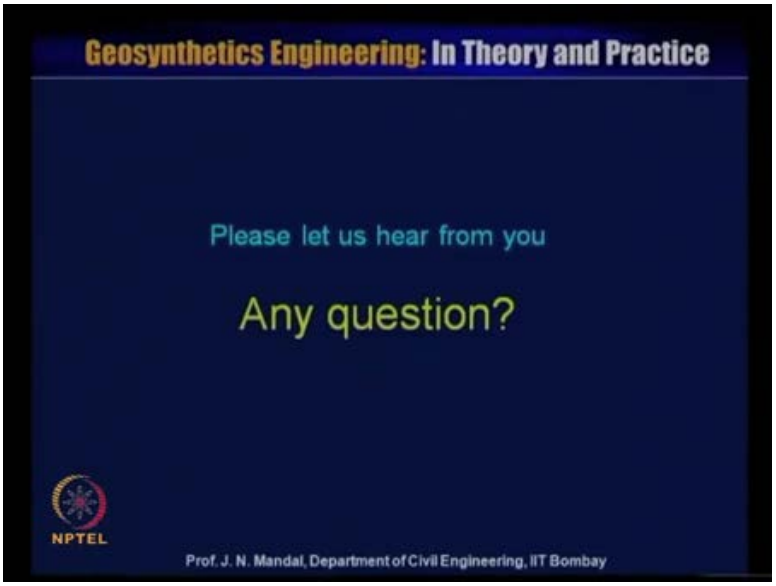

So, what we have covered I think you have understood, how we can save the energy otherwise what will happen in the world in future. So, everybody has to be cautious about this what kind of material should use, how you can safer to save the planet, how we can go for the green technology, which we can give for the lot of reliable energy and you can sustain yourself. So, you require proper kind of the management proper kind of the planning, so we know that that people can sustain in their own renewable resources, please let us hear from you any questions.

Thanks for listening.