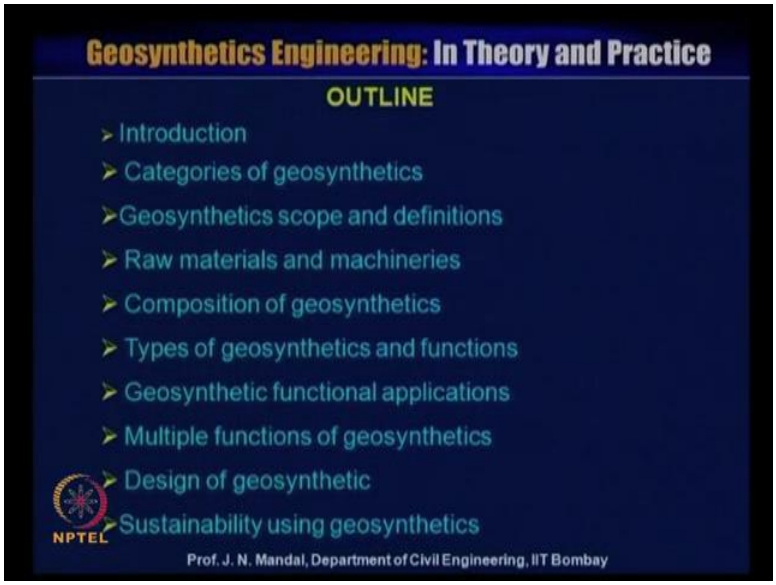
Geo synthetics Engineering: In Theory and Practice
Prof. J. N. Mandal
Department of Civil Engineering
Indian Institute of Technology, Bombay

Module - 2
Lecture - 6
An Overview of Geo synthetics

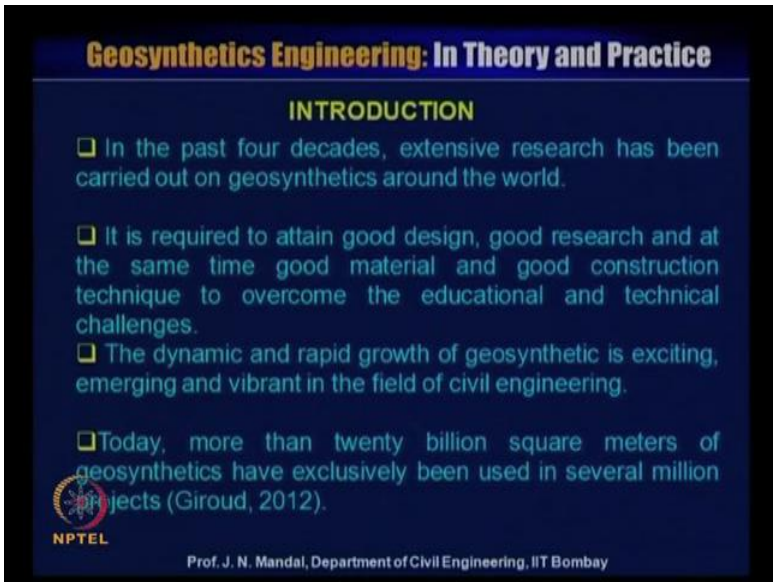
Dear student, warm welcome to NPTEL phase 2 program video course on Geo synthetics Engineering in Theory and Practice. My name is Professor J. N. Mandal, Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai, India. The name of the course Geo Synthetics Engineering in Theory and Practice, this module number 2, lecture number 6, an Overview of Geo synthetics. So far we talk about the metallic reinforcement I said that how the reinforced earth system, moved on to geo synthetics engineering system. We will focus on the different types of the geo synthetics material and their various application.

(Refer Slide Time: 01:43)



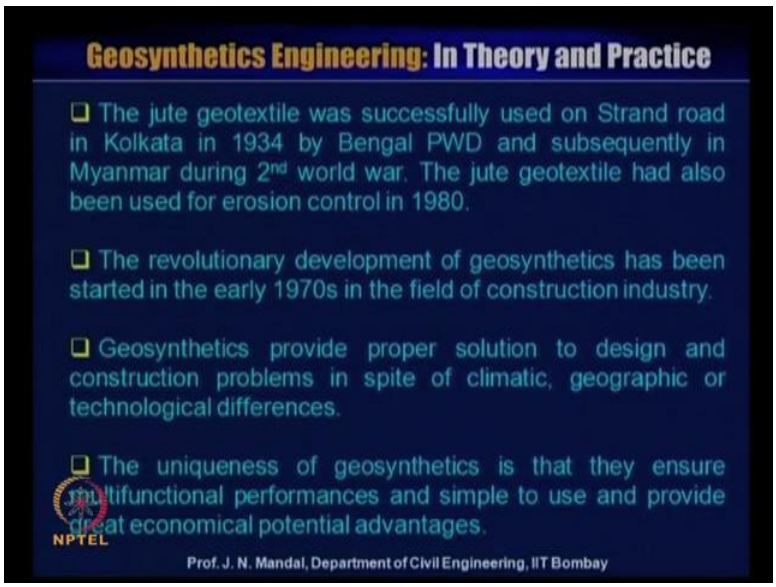
The outline of this course is introduction, then category of geo synthetics material, geo synthetics scope and definition, raw material and machineries, composition of geo synthetics, type of geo synthetics and function, geo synthetics functional application, multiple function of geo synthetics, design of geo synthetics and sustainability using geo synthetics material.

(Refer Slide Time: 02:23)



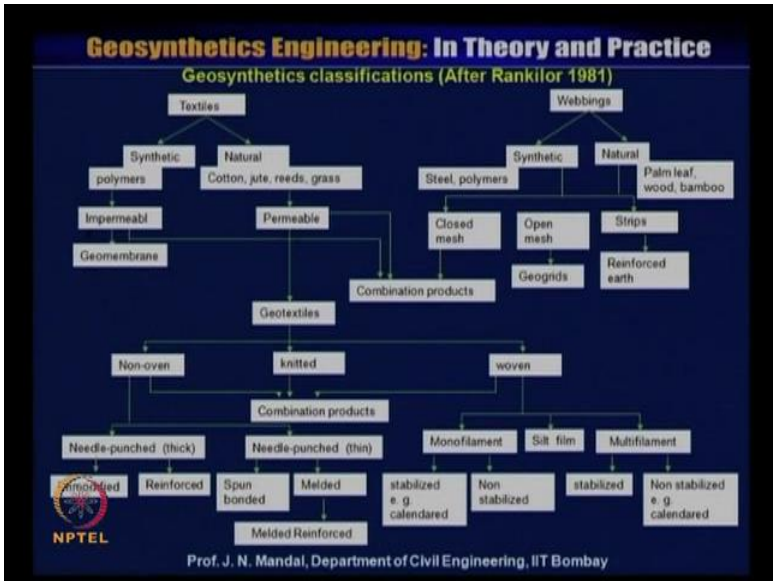
So, in introduction you know in the past four decade, extensive research has been carried out on geo synthetics around the world. It is required to attain good design, good research and at the same time good material and good construction technique to overcome the educational and technical challenges. The dynamic and rapid growth of geo synthetics is exciting, emerging and vibrant in the field of civil engineering. Today, more than 20 billion square meter of geo synthetics have exclusively been used in the several million project as per giroud 2012.

(Refer Slide Time: 03:30)



The jute geo textile was successfully used on strand road in Kolkata in 1934 by Bengal PWD and subsequently in Myanmar during 2'nd world war. The jute geo textile had also been used for erosion control in 1980. The revolutionary development of geo synthetics has been started in the early 1970's in the field of construction industry. Geo synthetics provide proper solution to design and construction problems in spite of climatic, geographic or technological differences, as I said the uniqueness of geo synthetics is that, they ensure multifunctional performance and very simple to use and provide get economical potential advantage.

(Refer Slide Time: 04:44)



So, we see that how geo synthetics can be used, in difference area and so many years how it has been used and how it has been potential application in various project, to understand this geo synthetics material, we should study that geo synthetics classification, after rankilor 1981. So, this geo synthetics that is textile material, it may be synthetic or it may be natural, synthetics mean it may be polymer or natural it may be jute, cotton, reed, grass.

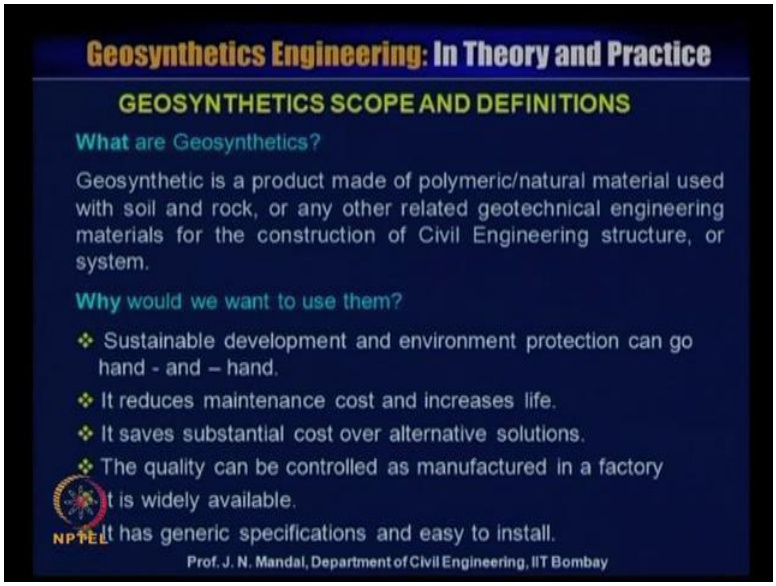
So, it may be that permeable material or it may be the impermeable material, if it is a impermeable material then geo membrane will be the impermeable material, again on the webbing this has a synthetic and the natural. And also you can say, steel polymer or natural like the palm, leaf, wood, bamboo or steel polymer have a closed mesh and open mesh and also the strip. If it is a closed mesh this is all combination of the product, either

it is a impermeable material or it is a permeable material or it is a webbing material, an open mesh that is called geo grid and strip what we talk about, that is reinforced earth.

So, we talk about this geo textile which is permeable material and that also have 3 category, one is the nonwoven category, another is the knitted, another is the woven category. So, nonwoven has also needle punched, thick it is may be unmodified of the reinforced and if it is a knitted generally most of the time not, so much used in the civil engineering and the woven geo textile material it may be monofilament, silt film or multifilament, again multifilament has the stabilized and non stabilized that is calendared and the monofilament may be the stabilized calendared or the non stabilized.

So, all these combination product also it may be needle, punched, thin it may be spun bounded, it may be melded or it may be the melded reinforcement. So, this is as a rankilor 1981 has classified these geo synthetics like this.

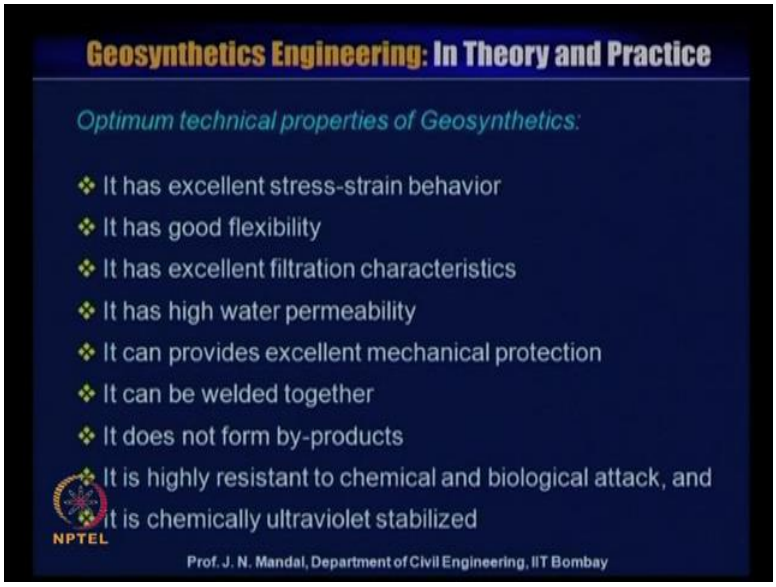
(Refer Slide Time: 08:14)



Now, what are the scope and the definition of the geo synthetics, these are generally question come to our mind that, what are geo synthetics, why we want to use them, what we want to use them, how you can use them, who manufacturing this geo synthetics material. So, definition of geo synthetics is geo synthetics is a product, made of polymeric, natural material used with the soil and rock or any other related geotechnical engineering material, for the construction of civil engineering structure or system.

Why would we want to use them, this sustainable development and environmental protection can go hand in hand, it reduces, maintenance cost and increases life, it is save substantial cost, over alternative solution, the quality can be controlled and manufactured in a factory because you can manufactured as you like it because it is made in a machinery. So, manufacturer can produce the geo synthetics material, as per desired by the designer, it is also widely available and it has generic specification and also it is easy to install.

(Refer Slide Time: 10:17)

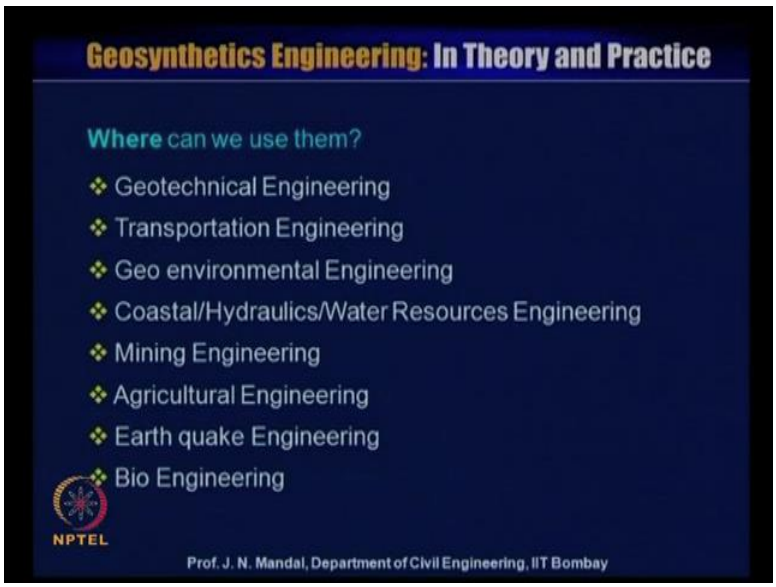


It give also optimum technical properties of geo synthetics, it has excellent stress strain behavior, it is a good flexible material, it is a excellent filtration characteristic, it has a very high water permeability, it can provide excellent mechanical protection, it can be welded together, you can stitch it. You can weld it, it does not form by product, it is highly resistance to chemical and biological attack and it is chemically ultraviolet stabilized.

(Refer Slide Time: 11:08)

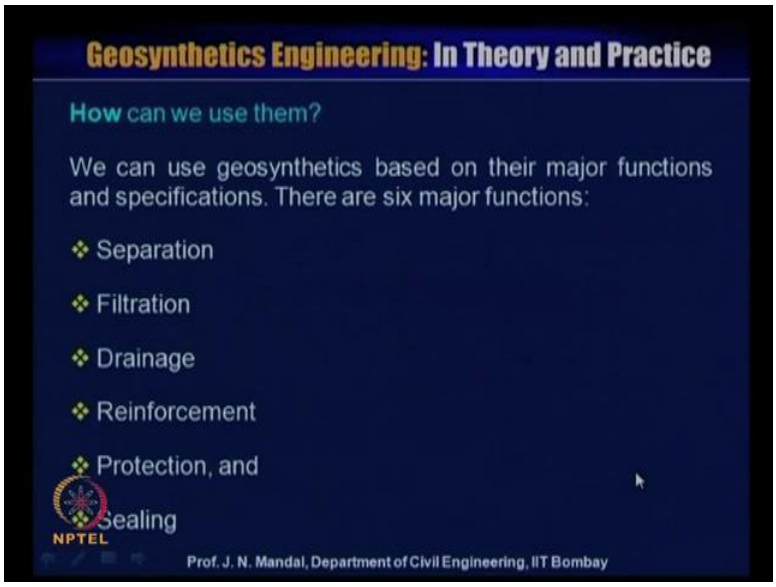
When can we use them, we can use them when the load bearing capacity of the soil, we can use when the excessive settlement of the soil, there is no other system how you can use that, if it is a soft soil treatment or reclamation of the land, when the limited space for the construction, you can save the land, you can control and protect the environment. And if it is a swelling soil, you can do faster construction, you can save the time, you can save the cost and sustainable environmental safety and you can maintain the quality assurance and the quality control.

(Refer Slide Time: 12:09)



Now, where can we use, this geo synthetics material, you can use in various engineering division, you can use geotechnical engineering problem, transportation engineering problem, geo environmental engineering problem, coastal, hydraulic, water resources engineering problem, mining engineering, agriculture engineering, earth quake engineering and bio engineering, you can see there are many area, where we can use this geo synthetics material.

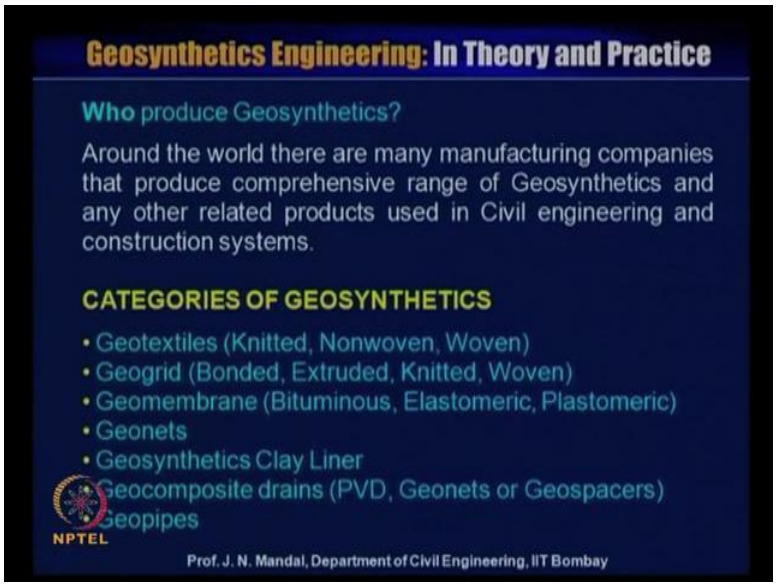
(Refer Slide Time: 12:50)



How can we use them, how can we design them. So, we can use the geo synthetics based on their major function and specification, this is very important, that what will be their major function, what should be their primary function, what should be their secondary function. So, here I am mentioning only 6 major function, that is separation, filtration drainage, reinforcement, protection and sealing. So, these are the major that 6 function when, we will design any geo synthetics material in any project.

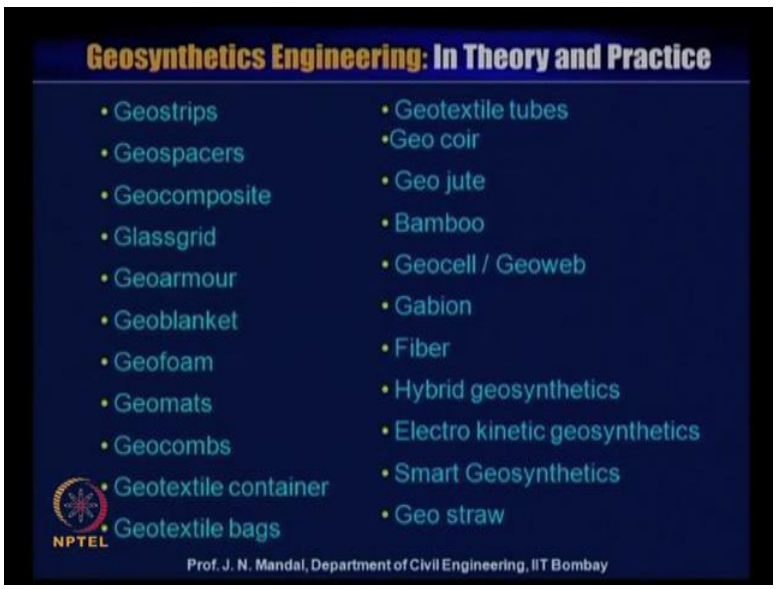
So, we have to know, that what are their function, this is very important to understand their functional concept, whether it is a separation, whether it is a reinforcement, whether it is a filtration, whether it is a drainage or whether it is a sealing. So, we have to be select, what should be their primary function and what should be their secondary function.

(Refer Slide Time: 14:17)



Now, who produces the geo synthetics material, around the world there are many manufacturing company, that produce comprehensive range of geo synthetics and any other related product used in civil engineering and the construction system. Now, next looks what will be the category of the geo synthetics material, geo textile it may be know knitted, nonwoven and woven, geo grid it is a bonded, extruded, knitted, woven, geo membrane it may be bituminous, elastomeric and plastomeric, geo net, geo synthetics clay liner, geo composite drain that is PVD Prefabricated Vertical Drain, geo nets or geo spacers or geo pipes.

(Refer Slide Time: 15:20)

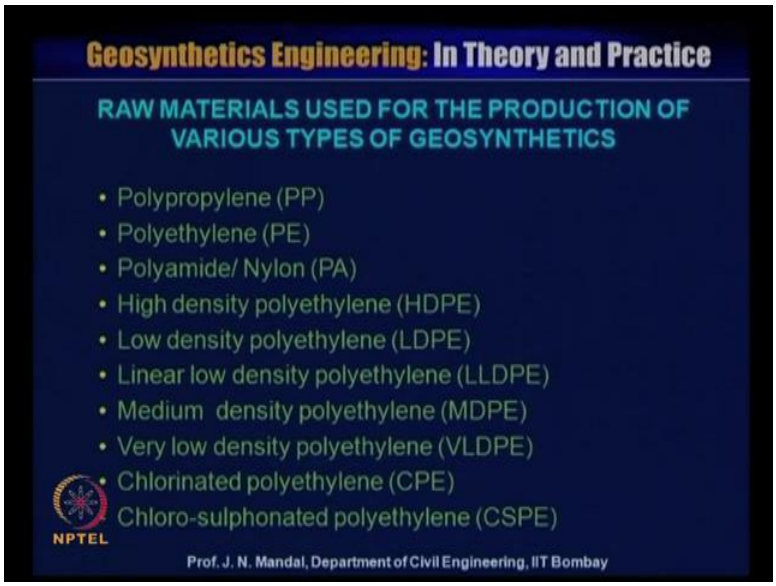


So, you can see that different types of the material and different types of the product. So, you have to select that, proper kind of the product for a proper application, it may be needle punch, it may be heat bonded. So, you have to be careful that which product will be suitable for a particular project.

Now, there are many, many material you say that geo strips, geo spacer, geo composite, glass grid, geo arm our, geo blanket, geo foam, geo mats, geo combs, geo textile container, geo textile bag, geo textile tube, even then natural material, geo coir, geo jute, bamboo or geo cell, geo web, gabion, fiber, hybrid geo synthetics, electro kinetic geo synthetics, smart geo synthetics and geo straw, you can see that there are various types of the geo synthetics material, whether it may be the natural material, like a jute or the coir which is made from coconut fiber or it may be metallic strip.

So, all this material is under the umbrella of geo synthetics, though geo synthetics is a polymer material, but we have taken into consideration, the all the material will as a families of the geo synthetics.

(Refer Slide Time: 17:29)

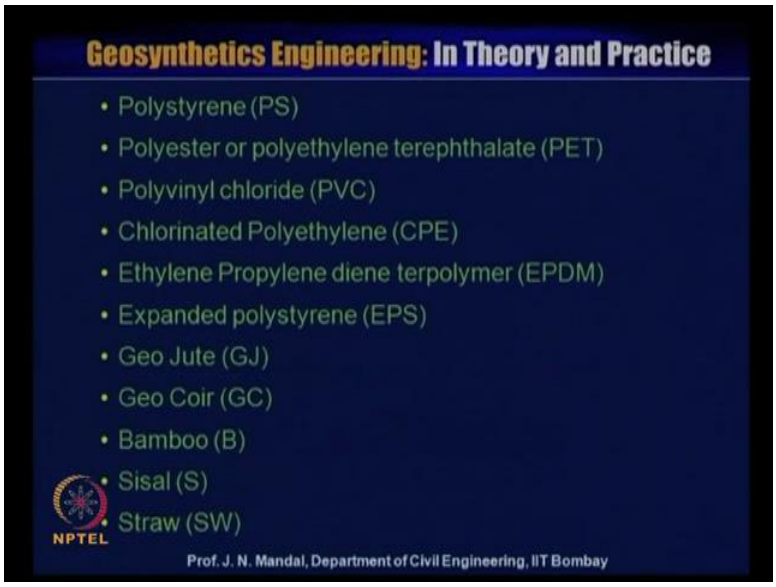


So, for this geo synthetics that raw material what we use for the production of geo synthetics material is different. So, raw material what we use for the production of various types of geo synthetics and that we may call polypropylene, polyethylene, Polyamide, Nylon it is called PA or High Density Polyethylene called HDPE, Low Density Polyethylene it is LDPE, Linear Low Density Polyethylene LLDPE, Medium

Density Polyethylene MDPE, Very Low Density Polyethylene which VLDPE, Chlorinated Polyethylene CPE or Chloro-Sulphonated Polyethylene CSPE.

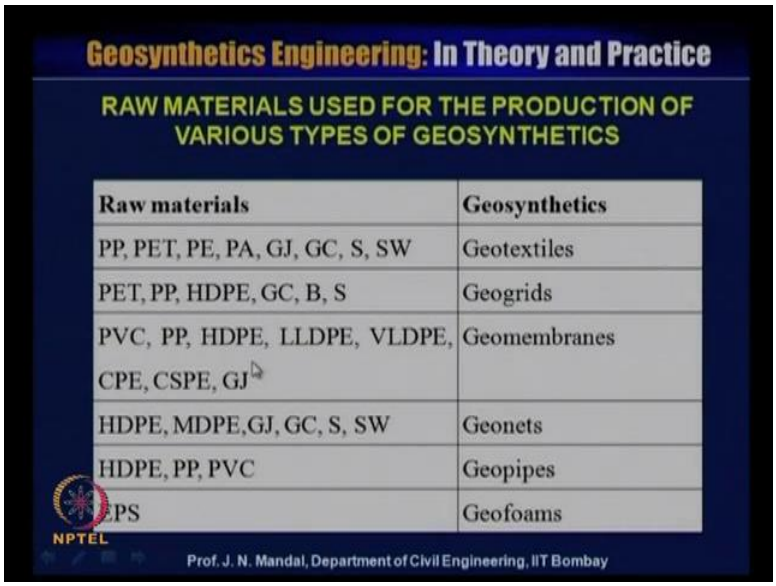
So, these are some designation has been given for the different material and different product. So, we have to keep in mind that what is PP Polypropylene, what is p polyethylene, what is PVC Polyvinyl Chloride, what is PT Polyester. So, you have to remember, these term in the short, short form.

(Refer Slide Time: 18:58)



Also there are some other material like, polyester which is designated as PS Polyester or Polyethylene Terephthalate that is PET, Polyvinyl Chloride PVC, Chlorinated Polyethylene CPE, Ethylene Propylene Diene terpolymer that is EPDM which you call the rubber, then Expanded Polystyrene that is EPS it is called geo foam or thermocol and Geo Jute is GJ, Geo Coir is GC, Bamboo is B. So, Sisal is S and Straw you can define as S of W.

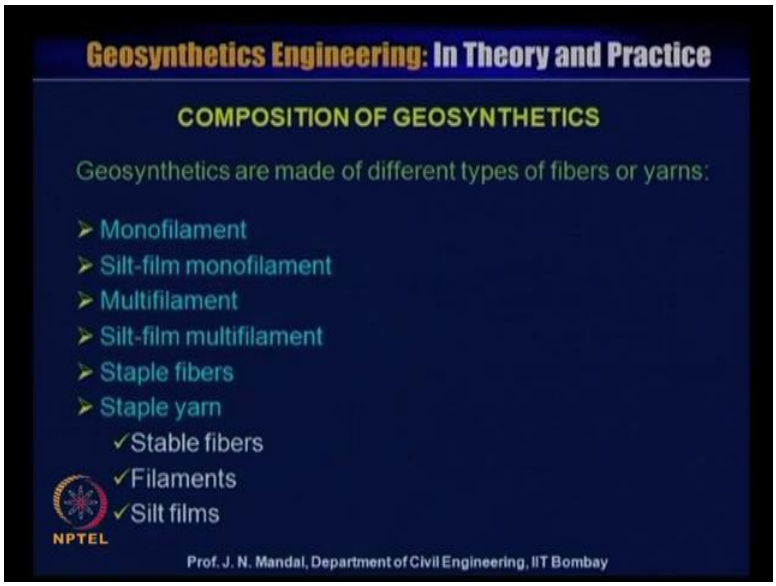
(Refer Slide Time: 19:49)



So, these are the some observed designation is given by for the different kind of the product. So, we will show that how this raw material used for the production of various type of the geo synthetics material. So, we are showing that one side that what is the raw material and what should be the product of the geo synthetics material.

You can see this table PP, PET, PE, PA, GJ, GC, S, SW we can say geo textile material, PET, PP, HDPE, GC, B, S this is geo grid which I have already explained what is this abbreviation, then PVC, PP, HDPE, LLDPE, VLDPE, CPE, CSPE, GJ geo synthetics is geo membrane, HDPE, MDPE, GJ, GC, S, SW is geo net, HDPE, PP, PVC is geo pipe, EPS is geo foam. So, there are different raw material and different type of the product, it may be geo textile, it may be geo grid, it may be geo membrane, it may be geo foam. So, you can see that various type of the material and which is made of various type of the polymer.

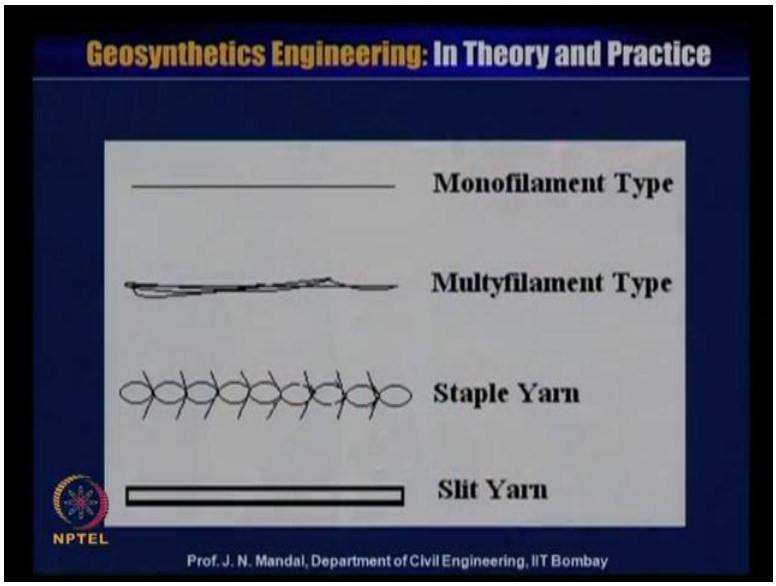
(Refer Slide Time: 21:25)



Now, what is the composition of the geo synthetics. Now, geo synthetics are made of different types of fiber or yarn. It looks like a cloth or you can see some rope, you can see that some geo synthetics material are made of some yarn, this is a it may be the monofilament, it may be silt film monofilament, it may be multifilament, silt film multifilament, then it is staple fiber, staple yarn and that also has a staple fiber, filament and silt film.

So, you can see the different type of the filament. So, again you have to select, what you can suggest for the monofilament, what we will suggest for the silt film monofilament or the multifilament or it is a stable fiber or it is a filament or it is a silt film. So, that is way it is also needed, more knowledge about the textile engineering.

(Refer Slide Time: 22:52)



So, you can see in this slide that this is monofilament type, this is multifilament type, this is staple yarn or this is slit yarn. So, you can see that how the variation of the different types of the filament.

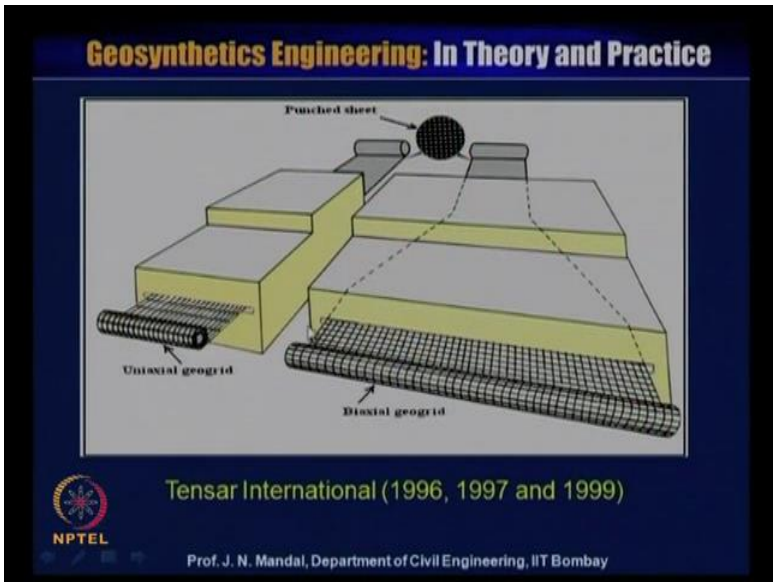
(Refer Slide Time: 23:13)

Now, again that woven geo synthetics and the knitted geo synthetics can be made of yarn as follow, that is monofilament yarns, spun yarn, multifilament yarn, a fabricated yarn and the slit film yarn. The nonwoven geo synthetics material can be made of stable fiber or filament. The arrangement of the fiber in random and bonded together with the

following system because nonwoven geo synthetics material may be mechanical bonding, chemical bonding, heat thermal bonding, resin bonding, spray bonding, spun bonding, stitch bonding.

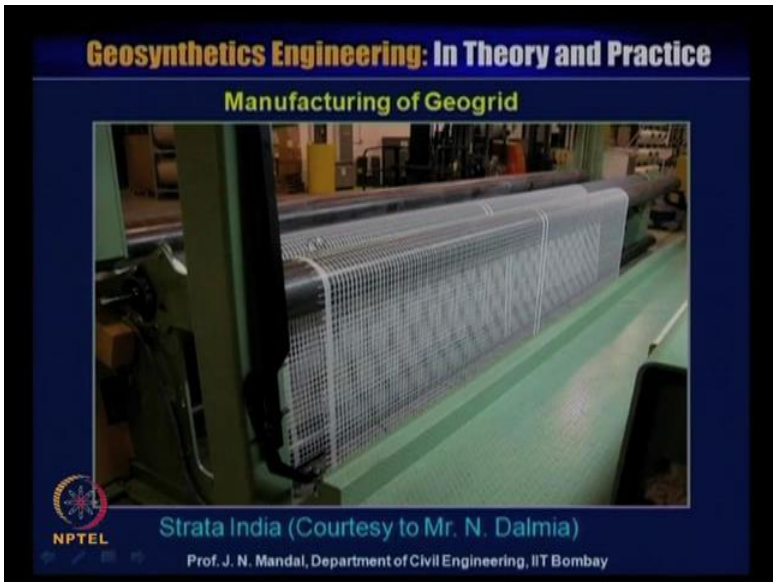
So, when you will select that any kind of the geo synthetics material. So, whether it is a woven or it is a nonwoven geo synthetics material. So, you are to be know that what is made of, whether it is a woven, whether it is a nonwoven, whether it is a woven in case of whether, it is a monofilament spun bonded slit film etcetera. Similarly, for the nonwoven geo synthetics material you should also know what should be the type of the material, whether it is a heat bonded, whether it is a mechanically heat bonded.

(Refer Slide Time: 25:05)



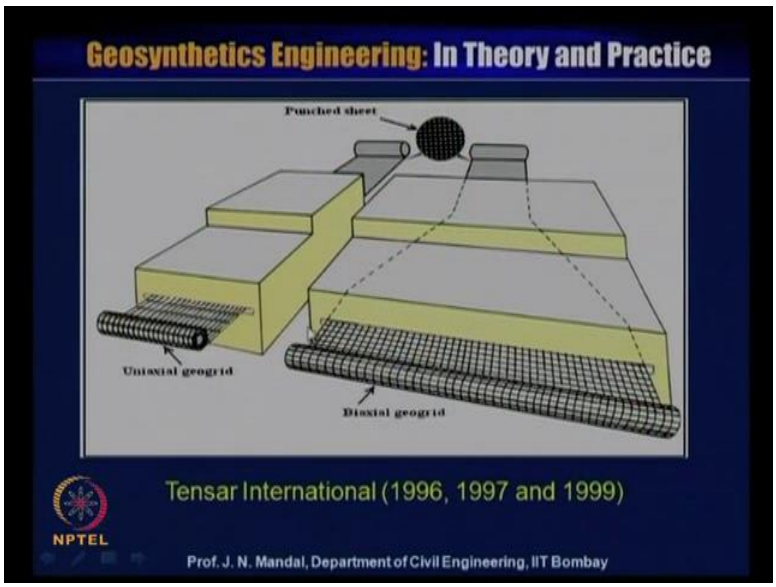
So, this you are to be careful that what is the type of the material? It is... So, this material is manufacture.

(Refer Slide Time: 25:09)



Manufacture of this is a kind of the geo grid and this is strata India, courtesy to mister n Dalmia you can see this is a machinery and this is the roller and you can see how they are manufacturing the geo grid material, which is a polyester material. So, it has a particular width it may be 3 meter to 6 meter and also length wise you can see 500 meter, 1000 meter you can have in the different form of roll form.

(Refer Slide Time: 25:47)

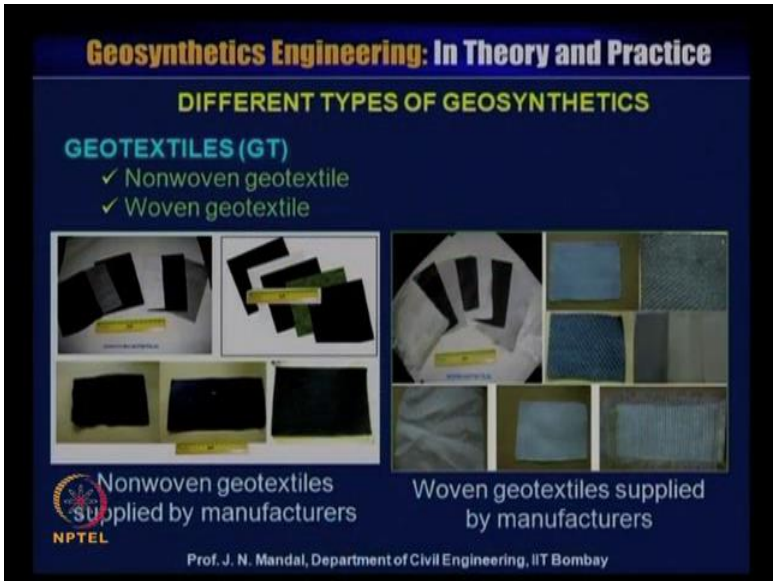


You can see that uniaxial geo grid and also the biaxial geo grid, this is tensar international 1996, 1997 and 1999 it is the punched sheet and how you can manufacture

this uniaxial geo grid, this geo grid has a tensile strength, is the strength either in the machine direction or the cross machine direction or this biaxial geo grid, these tensile strength is more in the machine direction and it may be relatively less in the cross machine direction.

So, what we observed that, there are different type of the manufacturing system, in which we can manufacture these woven geo textile material, nonwoven geo textile material and also that we can manufacture different types of the geo grid, it may be the biaxial geo grid or it may be the uniaxial geo grid material. So, we should know that, what are the different types of the geo synthetics material and what it is made up and what how we are manufacturing the geo synthetics with the different manufacturing system.

(Refer Slide Time: 27:21)



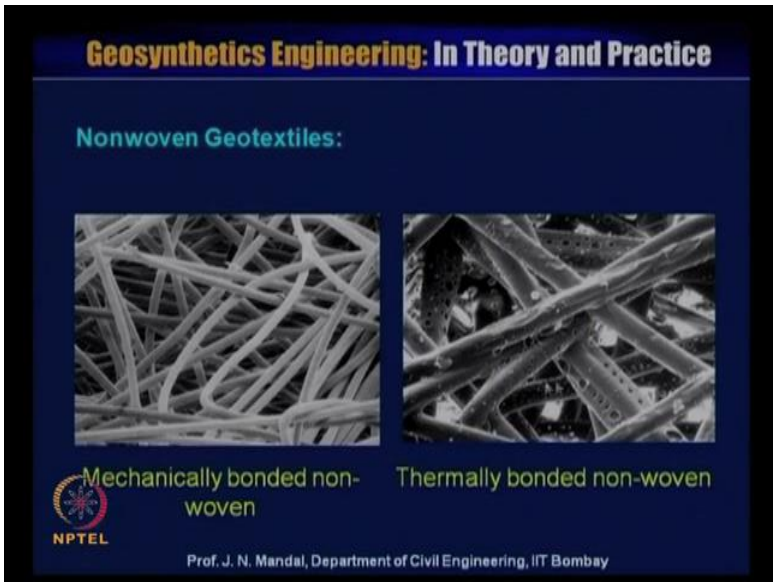
Now, I will show you the different types of geo synthetics product, first geo textile. It may be nonwoven geo textile or woven geo textile, this is nonwoven geo textile material and this is woven geo textile material, I can show you that the kind of nonwoven geo textile material, this is the nonwoven geo textile material and for the filament are very random. So, it has a machine direction, as well as cross machine direction, also it has a diagonal direction.

So, tensile strength of machine and cross machine direction, almost equal even then it should be equal in the diagonal direction. So, this is a nonwoven geo textile material, this is also another also nonwoven geo textile material, whose filament you can see very

random and this is the woven geo textile material, this is a natural material, this is we call jute geo textile, you can have also polyethylene, polypropylene woven geo textile material, you can see in case of woven geo textile material, this filament are perpendicular to each other and it has also have a different opening side.

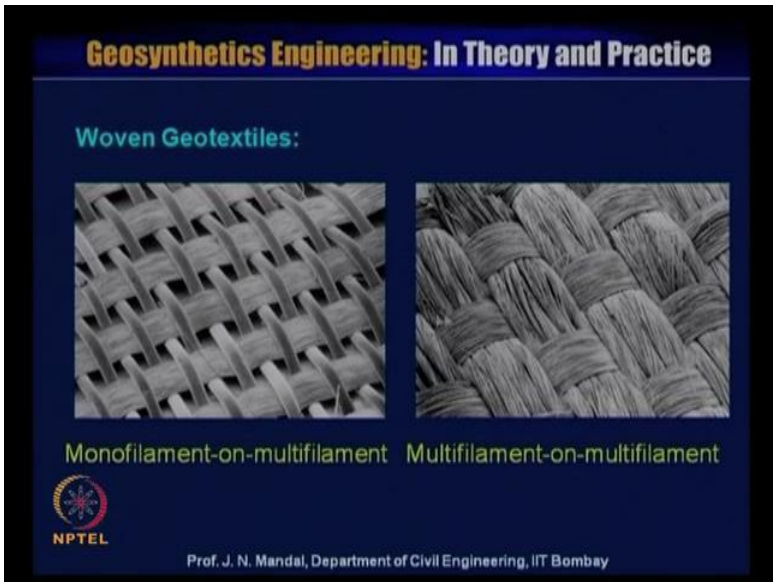
So, this I am just introducing you about the geo synthetics product, so this product particularly used for, the filtration, drainage and separation function.

(Refer Slide Time: 29:55)



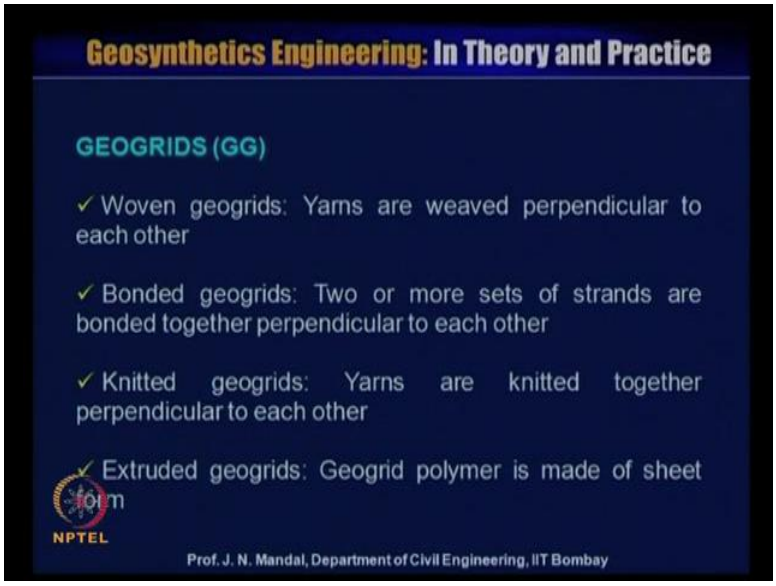
You can see that mechanically bonded nonwoven geo textile material, this is thermally bonded nonwoven geo textile material, if you skips can you can see that what is inside, in case of nonwoven geo textile material. If it is a mechanically bonded you can see that how the filament are bonded, here and in case of thermally bonded nonwoven geo textile material you can see that how the filament are bonded.

(Refer Slide Time: 30:36)



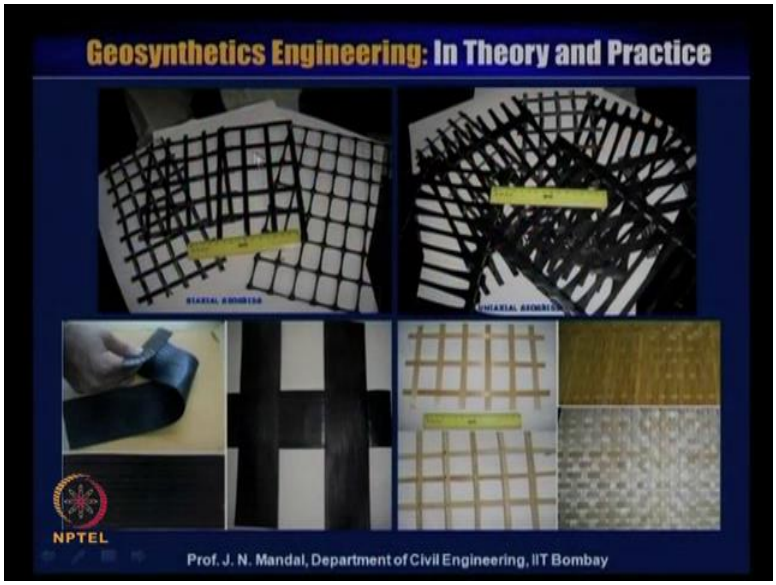
Now, this is you can see woven geo textile material, this is monofilament and this is multifilament, this one is multifilament, this one is monofilament. So, this woven geo textile call the monofilament on multifilament, monofilament on multifilament, you can have also multifilament on multifilament. So, you can see that woven geo textile also have the different types of the filament, it may be either monofilament, on multifilament or multifilament on multifilament. The next I will show you the geo grid.

(Refer Slide Time: 31:37)



So, this geo grid material have a woven geo grid; that means, yarn are weaved and perpendicular to each other, there is a bonded geo grid two or more sets of strength are bonded together perpendicular to each other or knitted geo grid, yarn are knitted together perpendicular to each other and extruded geo grid, the geo grid polymer is made of sheet form. I have showing you some of the geo grid material.

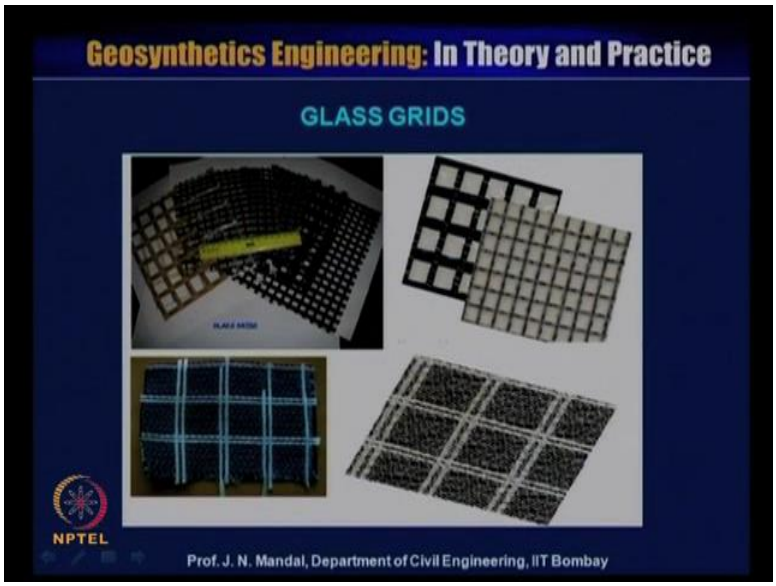
(Refer Slide Time: 32:18)



This geo grid material is biaxial geo grid material, you can see here. This is the biaxial geo grid material and that mean that tensile strength in the machine and cross machine direction is the same or you can have a uniaxial here, the uniaxial geo grid. Let me see you can have a tensile strength, in the longitudinal direction also in the transverse direction.

So, there are mainly the 2 types of the geo grid material, it may be made of or as to call the bamboo geo grid you can make a bamboo grid and we have done lot of research work in this related area and also we are used, some kind of Para grid, like this and also that you can sometimes say also the friction tie and if you conduct the test you can see that how the sample fell. So, these are the type of material, is exclusively used for a reinforcement function, apart from that woven, nonwoven, geo textile and geo grid you have also the glass grid.

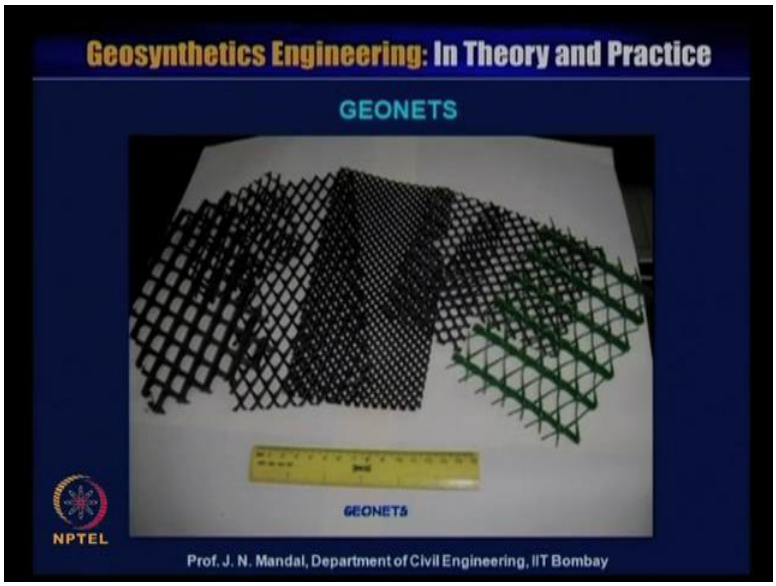
(Refer Slide Time: 33:59)



You can see that different types of the glass grid and this is the glass grid, it has a tensile strength may be 50 kilo Newton per meter or 100 kilo Newton per meter and this material is have very high strength and it can be used for the refraction cracking, in the air fill pavement, also there are other type of this material, this also like a some filament on this direction, also in the this direction and also like a mat.

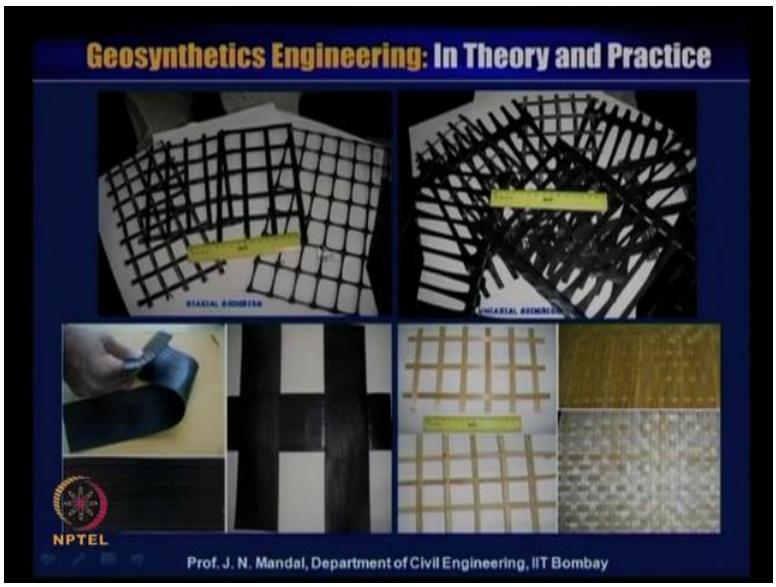
So, this is very high strength, of a kind of the glass grid material, this kind of the material may be the woven and very high strength filament and this also can be used for the reflection cracking.

(Refer Slide Time: 35:08)



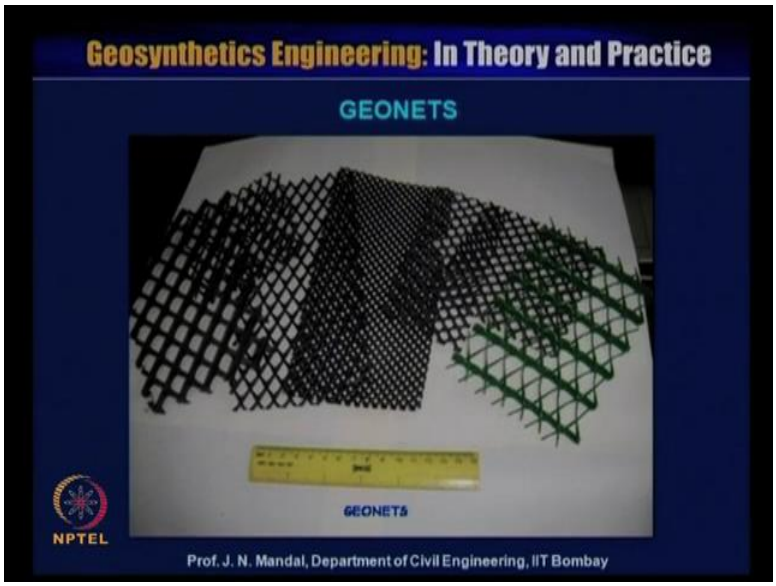
Next material is the geo net and this geo net, you can see here, that this is the geo net in rhombus in shape, it is not the same as.

(Refer Slide Time: 35:25)



I show you in case of the geo grid material, like a biaxial geo grid material, whose shape and size is something different.

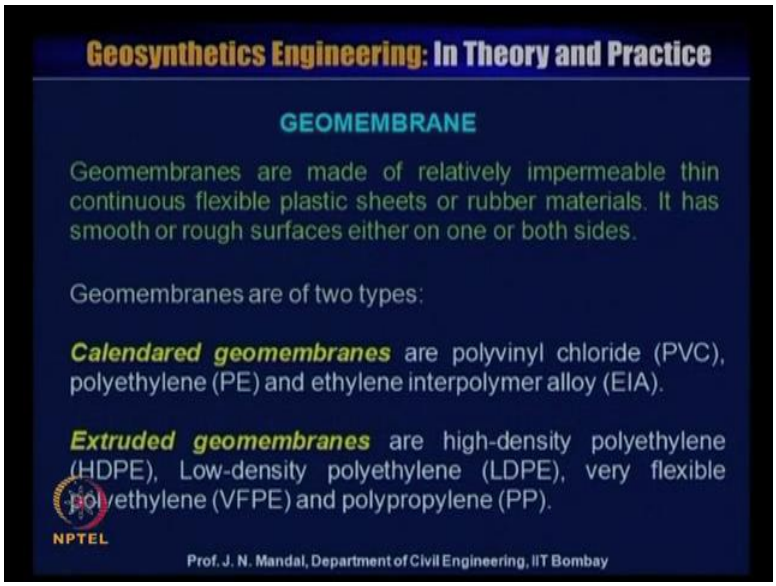
(Refer Slide Time: 35:36)



But, in case of the geo net you can see this opening side is rhombus in shape and this also have a triaxial type of geo net, this is triangle this is very high flow. So, this way kind of geo net material, you can see, if it is a two dimensional of geo grid if you need more flow, you can use may be tri. So, this kind of the 3D, kind of the geo net material it will give very good drainage and filtration capacity and this also can be used as a drainage and the filtration and particularly it has been used in the landfill system.

Now, So, far what we talk about that is all permeable material, whether it is a woven geo textile material, nonwoven geo textile material or it is a geo grid or it is a geo net, those all are permeable material. Now, I will focus on the impermeable material and what is called the geo membrane. Now, geo membrane is like a rubber.

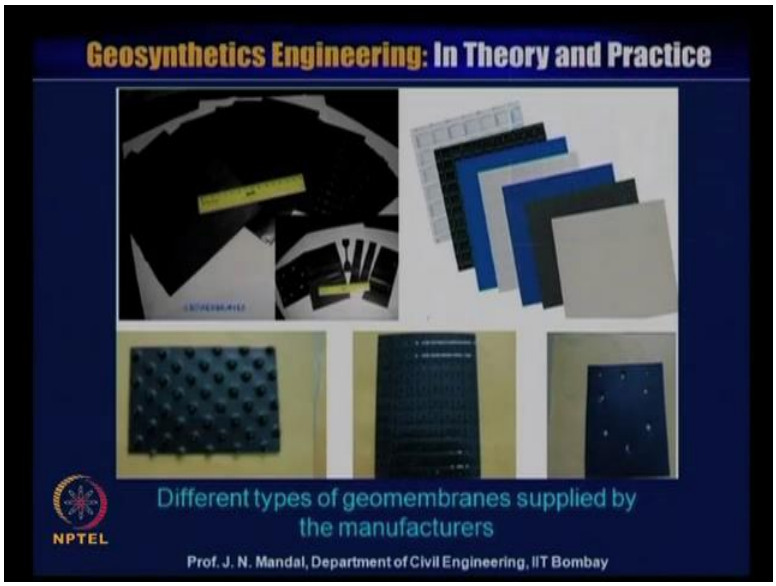
(Refer Slide Time: 37:17)



So, geo membrane are made of relatively impermeable thin, continuous, flexible plastic sheet or rubber material, it has a smooth or rough surface either one or both side, you can see that some of the geo membrane, you can see this geo membrane, this geo membrane surface is smooth in both the side, it is smooth both the side, it is smooth you can see it is smooth or in some cases, the geo membrane is one side is the smooth, but other side you can see rough, so where you require friction, development of fiction in a slope. So, you can use the geo membrane to resist.

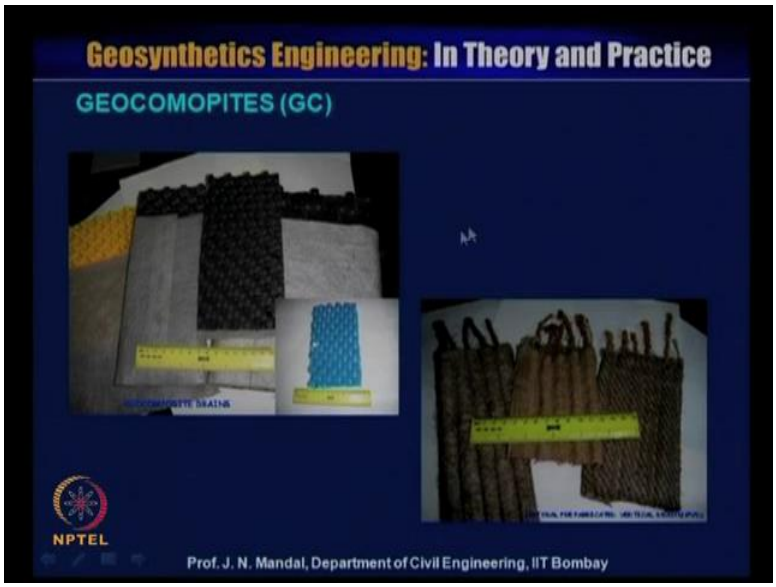
So, this geo membrane is exclusively used for the landfill, also it can be used for the dam, reservoir, tunnel, etcetera. So, this geo membrane are two types, one is calendared geo membrane, which are Polyvinyl Chloride which you call the PVC, Polyethylene which you call PE and Ethylene Inter polymer Alloy which you call EIA and extruded geo membrane are High Density Polyethylene which is represented as HDPE, Low Density Polyethylene that is LDPE, Very Flexible Polyethylene that is VFPE and Polypropylene which is PP.

(Refer Slide Time: 39:09)



So, you can see some here, also that the different types of the geo membrane, material and also you can see this is one side is the very rough. So, this is different types of the geo membrane.

(Refer Slide Time: 39:25)



Now, next is geo composite material, and geo composite means, this is all combination of the geo textile, it is a woven, nonwoven or the nonwoven geo net material or geo membrane, woven material any combination are called also the geo composite material, also the prefabricated multiple drain; that means, PBD is also called the geo membrane.

Even then you can see some natural material, which is made of the nonwoven jute material and coir, it also made of the woven jute material and the coir, also the other kind of the material, which you call the polymer material, this is outside is the spun bonded geo textile material and inside is the coir.

So, there are material like this, this is a made of the nonwoven jute material and this is coir, which is made from coconut fiber. So, coconut fiber filament wrap, with the nonwoven geo textile material and this we call the natural prefabricated vertical band length and this natural prefabricated vertical band drain can be used for the ground improvement and also for the drainage purpose. And there are also that woven, you can see that woven jute material and this is the coir fiber.

So, this coir is wrap with the woven geo textile material, this also we call the prefabricated vertical band drain and apart from that, there are material which also called the PVD and that PVD also it is made of polyester, this polyester has a outside core material and also inside core material, you can see that, this the PVD inside the core material and that is wrapped with nonwoven spun bonded, nonwoven geo textile material. And this is the, this you call the jacket and this you call the core and this also excessively use for, the ground improvement.

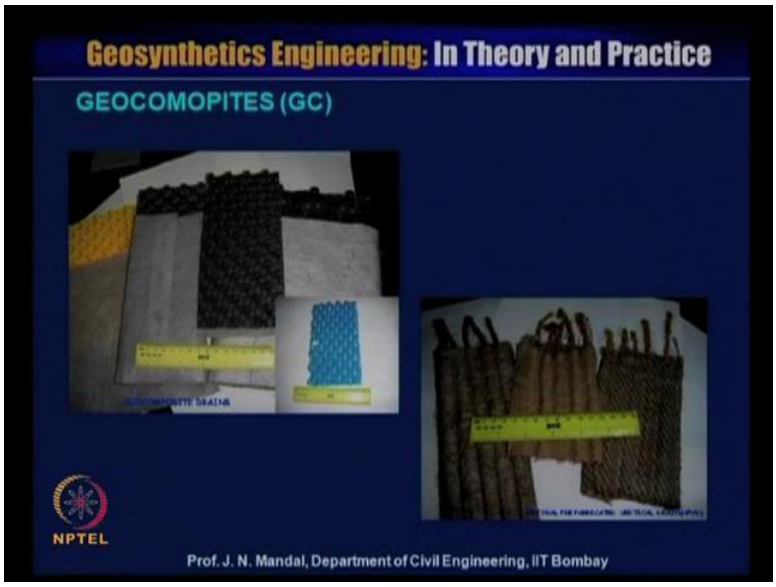
Apart from that, there are different types of the material you can see, this material, this is nonwoven, this is plastic coat also it can be call the geo composite material. So, there are many, many types of the geo composite material you can see this is the geo net and this is laminated with the nonwoven geo textile material, this also it call the geo composite material. So, any combination, you can see this is the geo grid and this is laminated with the nonwoven geo textile material, this also call the geo composite material.

So, there are various geo composite material, also geo composite material also used for the erosion control, as a mat. So, we use this natural material, like the woven jute material or the woven coir material for the erosion control and that is many, many years have been used for the erosion control. Now, it is also different types of the erosion control product, you can see it is a mesh, you can put it into the slope and then the grass can grow you can see there is a there is a opening size of this material.

So, you can use also as a erosion control mat, you can see the different types of the mat different types of the mat, you can see this is another type of the mat, then you can see

that gross can grow also and it looks very greenery. So, we can use for, erosion control system, you can see something like this geometry is something like this. So, you can have different shape and size of this material, you can see this is the coir material, also it act as a erosion control. So, this material exclusively used for the erosion control.

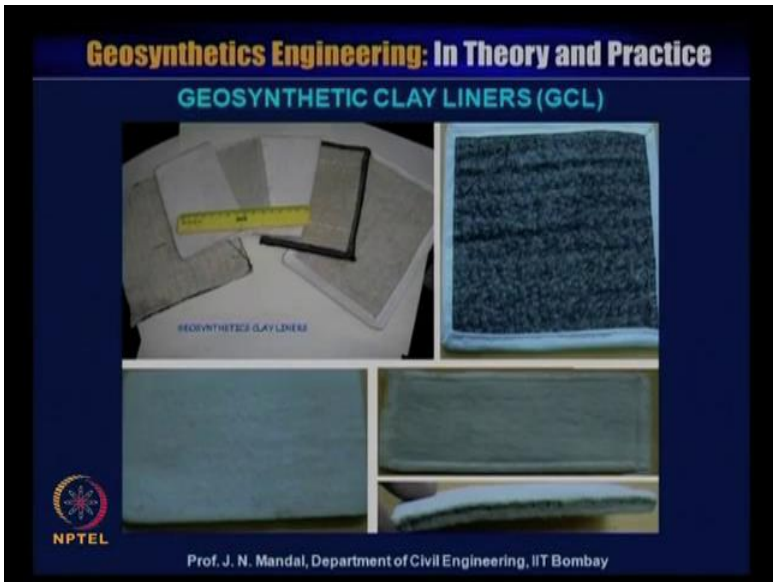
(Refer Slide Time: 40:38)



Now, there is a geo spacer or the geo strip material and it is also plastic, it is a coir, it may be laminated with the geo textile material and geo spacer and geo strip also use for the road side, also you can use it and for any stabilization of the soil, you can see like this geo space or geo strip also can be used for civilization for any foundation soil or you can use in the road, as a drainage, you do not need to excavate and fill up with the good quality of a aggregate or whether you have to use or woven or nonwoven geo textile material.

You can simply, that you can dig it you can see very less of the width of this material and this is laminated with the spun bonded nonwoven geo textile material, you can place along the both side of the road and this will act as a very good drainage. So, this we call the geo spacer or the geo strip.

(Refer Slide Time: 45:53)

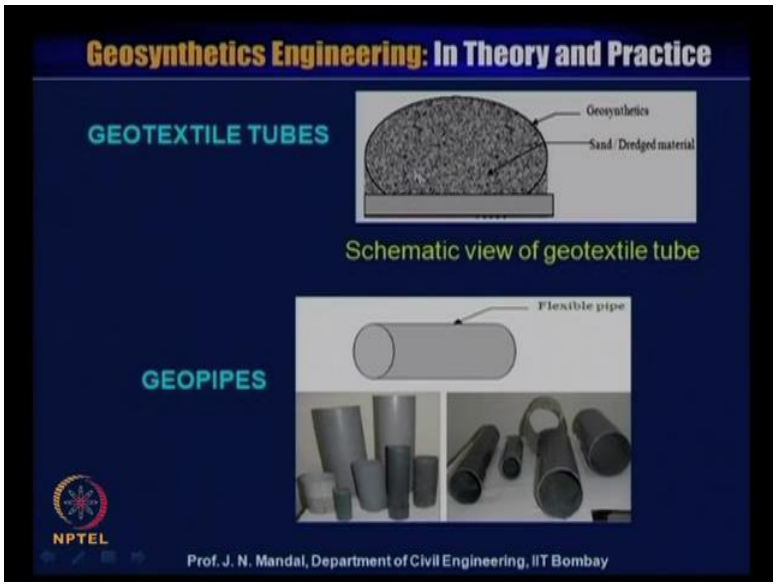


Now, there is geo synthetics clay liner, this is alternative to the geo membrane material and this material is made of bentonite, laminated with the woven material or nonwoven geo textile material, both the side nonwoven or both the side woven or one side is the nonwoven, other side is the woven or one side is the geo membrane, other side is the geo textile material. So, any combination of this which you call the geo synthetics clay liner, when this bentonite come in contact with the water and it will act as a impermeable material.

And showing you some of the sample you can see that bentonite and this top is the nonwoven geo textile material, this is needle punched nonwoven geo textile material, you can have also this also geo synthetics clay liner, you can see that nonwoven needle punched geo textile material on the one side and other side is the geo membrane. So, you can have a lot of combination of the geo synthetics clay liner, as the bentonite is abundantly available in India. So, we can also manufacture this kind of geo synthetics clay liner, which may be the much more cheaper than the geo membrane material.

So, it act as a barrier, it can be used for any landfill construction and other barrier system. Now, here slide show the geo textile tube

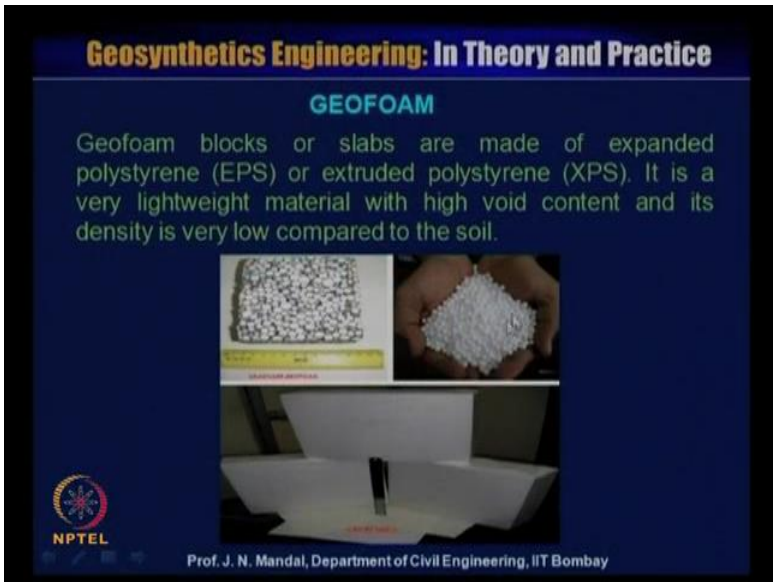
(Refer Slide Time: 47:39)



So, it is nothing but a like a gunny bag and fill up with the drainage material and then you can fill it and it can be placed, near to the seashore and to control the erosion. So, this is kind of the geo textile tube, we will also teach you about the geo textile tube in some of the chapter, and their I will explain more about this geo textile tube, which is very popular and it can be used in very difficult project or problems.

And this is what you call the geo pipe, it is already known to you, it is a flexible pipe. So, this is in general that it is known to you. So, it is also used as a drainage and filtration something like this. So, water can pass through this kind of the pipe. So, this is very, very standard it is also known to you.

(Refer Slide Time: 48:54)



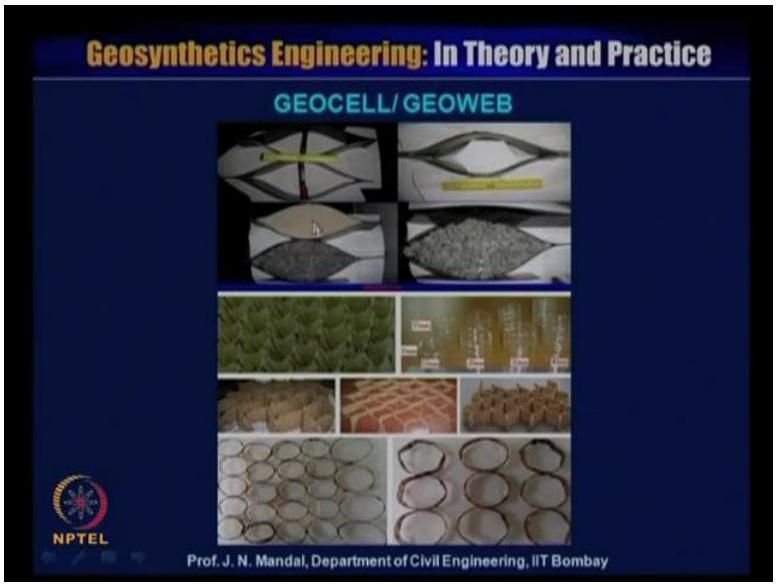
Now, this is the geo foam material, that is geo foam block or slab are made of expanded polystyrene or extruded polyester, it is a very light weight material with high void content and is density is very low, compared to the soil. So, this geo foam, in terms of the textile we say the expanded polystyrene material and generally, we use geo foam what is called the thermocol, we use plenty in packaging for the any TV, radio or lot of electronic goods and it is a superlight material.

So, you can have this in the form of beads and also you can have from the solid, you can see some of the, in the form of the beads also you can have some form of the dust. So, this beads at a particular temperature and pressure. So, you can produce this kind of the geo foam material. So, you can have this kind of the block. So, this block is have a different density. So, it may be, the from 10 to 30, 40, 50. So, this density can have a different density of this material and this is very you can see very super light material.

So, you can place directly on the soft soil and you can construct this a manmade using this, new super light material what we call geo foam, this geo foam also can have it in the form of drainage, you can see this beads and there is a opening. So, it can act also as a drainage, you can place of the back of the retaining wall, which will act as a drainage material, it is lighter it also give the drainage material, sometimes you can make the combination of this geo foam material and this geo foam material which will act as a drainage, this geo foam material which will act as a separation.

So, we can make use of the geo foam in different application.

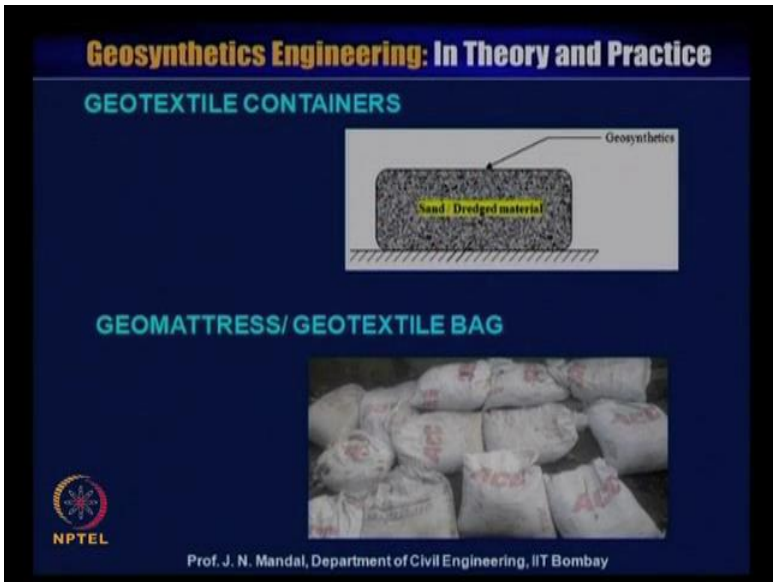
(Refer Slide Time: 51:32)



Next, I will talk about the geo cell, it is the geo cell it is a hexagonal or in honeycomb structure, it is made of polyester, it is made of also the natural material, you can see this is a natural material, geo cell or geo web or it is a made of the plastic, you can see that bottle, which we can cut and can make a cellular reinforcement. And just showing that one this geo cell is like this, you can you can collapse you can transport and it can be expanded and you can anchor and fill up with the aggregate or sand and can compact it.

So, this kind of the geo web or the geo cell, can be used for the road bead stabilization and also from the erosion control.

(Refer Slide Time: 52:40)



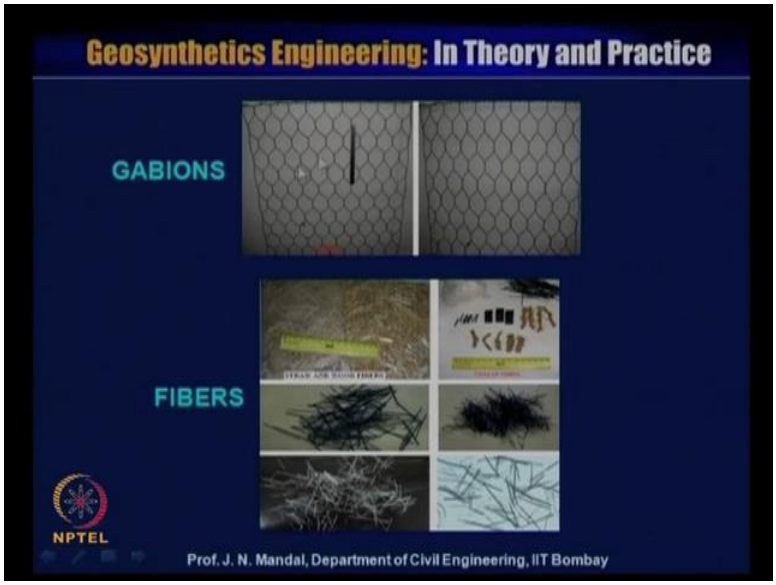
Now, this is geo textile container, nothing like a geo textile bag, this material is filled up with the drainage material and it can be also used for the erosion control and sea product.

(Refer Slide Time: 52:53)

Apart from the polymer material, there is a natural geo textile material, which is made of the jute and also as well as coir, this is then you can see jute planet, from this jute plant we produce this natural jute material, you can see like this kind of the jute material, we can produce also from the coir, this is the coir coconut planet and from which you can

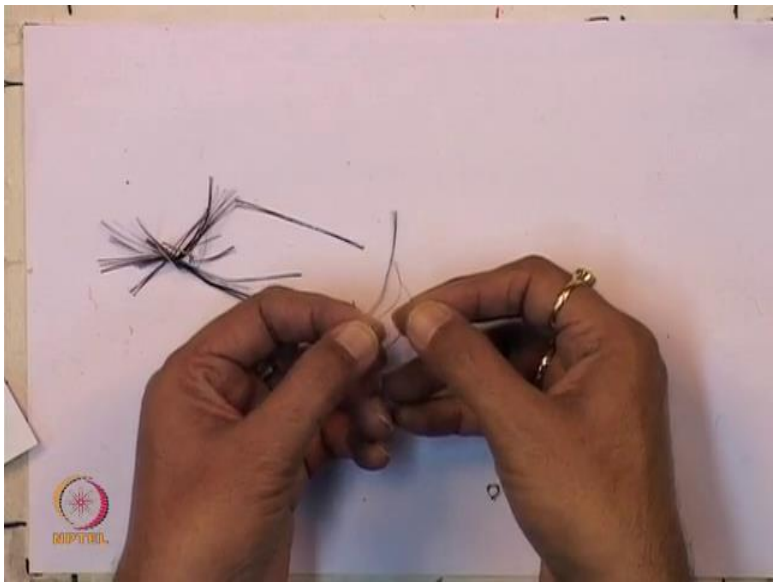
also produce this coconut fiber and coconut mat and this also exclusively used for the erosion control.

(Refer Slide Time: 53:30)



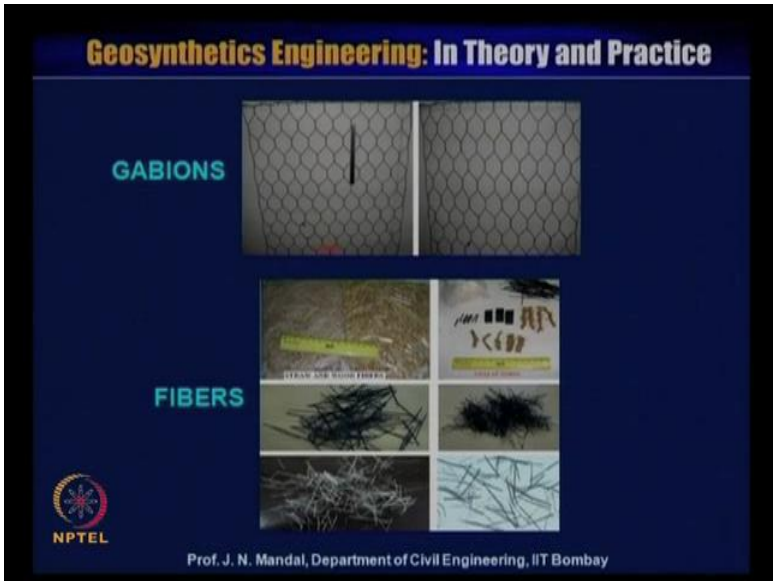
This is a gabion, this is a hexagonal, this is a galvanized mild steel, it is in the form mesh you can have a queue 1 meter by 1 meter queue and top portion is open and fill up with the good quality aggregate and compact it and you can construct this reinforced soil wall as a gabion. You can use different types of the fiber element.

(Refer Slide Time: 54:01)



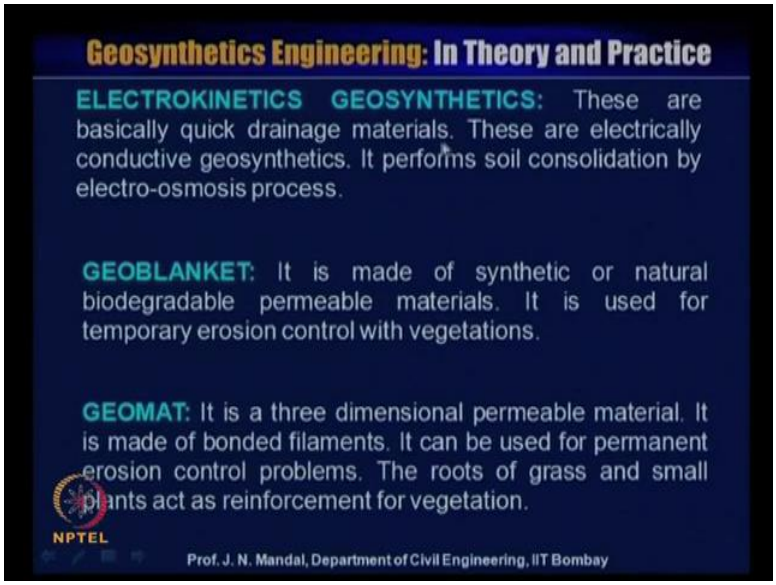
I have shown you earlier also what is the different types of the fiber, this is one type of the fiber, you can see, you can expand it you can have a cellular kind of the reinforcement, then soil can inserted into this opening place of this material and there will be good bonding, there will be interaction, good interaction between the different types of the fiber element with the soil.

(Refer Slide Time: 54:24)



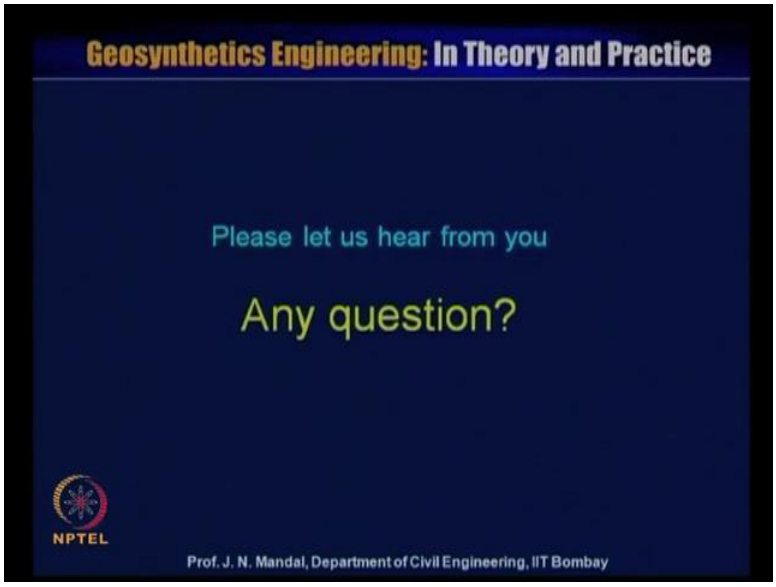
It may be the nylon, it may be the coir, it may be the jute or any kind of this material which is can be used for to stabilize the soil.

(Refer Slide Time: 54:40)



Now, the electro kinetic geo synthetics, these are the basically quick drainage material, these are electrically conducted geo synthetics material, it performs soil consolidation by the electro-osmosis process, that is a geo blanket it is made of synthetic or natural biodegradable permeable material, it is used for temporary erosion control with vegetation, that is geo mat it is a three dimensional permeable material. It is made of bonded filament, it can be used for permanent erosion control problem. The roots of grass and the small points act as a reinforcement for vegetation.

(Refer Slide Time: 55:37)



With this I ended up today's program, please let us hear from you any question.

Thank you for listening.