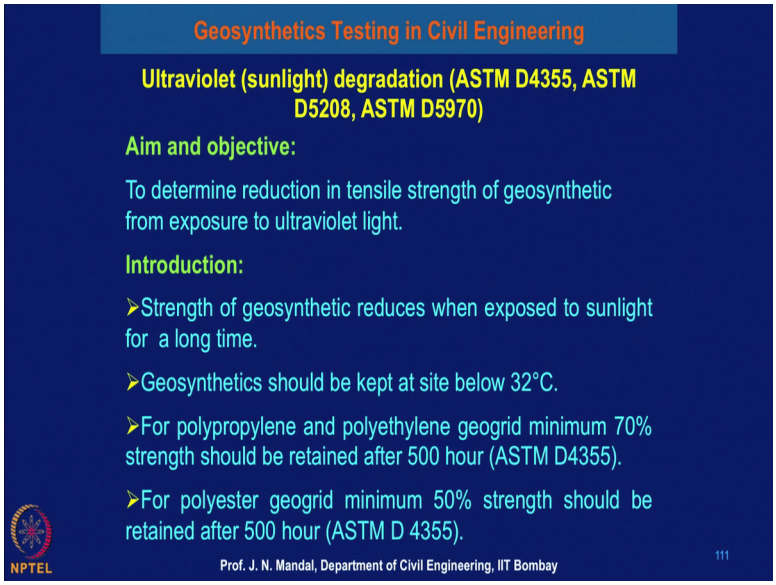
Geosynthetics Testing Laboratory
Prof. Jnanendra Nath Mandal
Department of Civil Engineering
Indian Institute of Technology, Bombay

Lecture – 15
Endurance properties of Geosynthetics

I am Professor J. N. Mandal, Department of Civil Engineering, IIT, Bombay. I will now teach you the ultraviolet or the sunlight degradation this is as per ASTM D4355 or ASTM D5208 or ASTM D5970. The main objective of this kind of the test is to determine the reduction of the tensile strength of Geosynthetics material from the exposure to ultraviolet light.

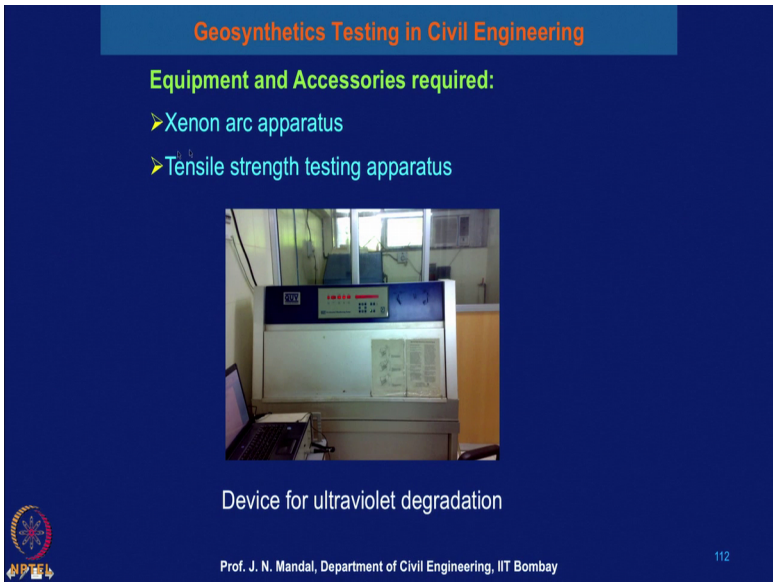
(Refer Slide Time: 01:01)



Now, strength of geo synthetics material may reduce when the expose in the sunlight for long time. So, you cannot keep the geo synthetics material for longer time in the sunlight because geo synthetics material may degrade. So, what percentage of degradation it would be?

So, geo synthetics material should be kept at a site below the 32 degree centigrade. For polypropylene and the polyethylene geogrid minimum 70 percentage of the strength should be retained after 500 hour as per ASTM D4355. For polyester geogrid minimum 50 percent strength should be retained after 500 hour ASTM D4355. So, one should maintain that time.

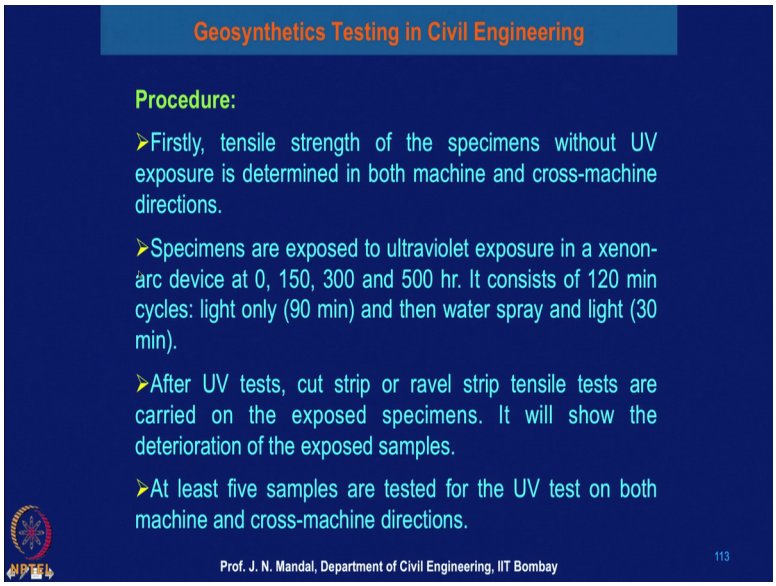
(Refer Slide Time: 02:40)



So, here now I will show you the equipment and the accessory required. So, this is Xenon arc apparatus and tensile strength of the testing apparatus. This is the device for ultraviolet degradation. So, in this device, you press the geosynthetics material.

Before that you have to perform that what will be the grab strength of the geosynthetics material and then you can press, the press material in the size of the grab strength and then you press it on this ultraviolet devices for a particular the time about 500 hour and then you take out the sample and determine the tensile strength of the geosynthetics material. Then, you will be knowing what will be the percentage of the geosynthetics material retained.

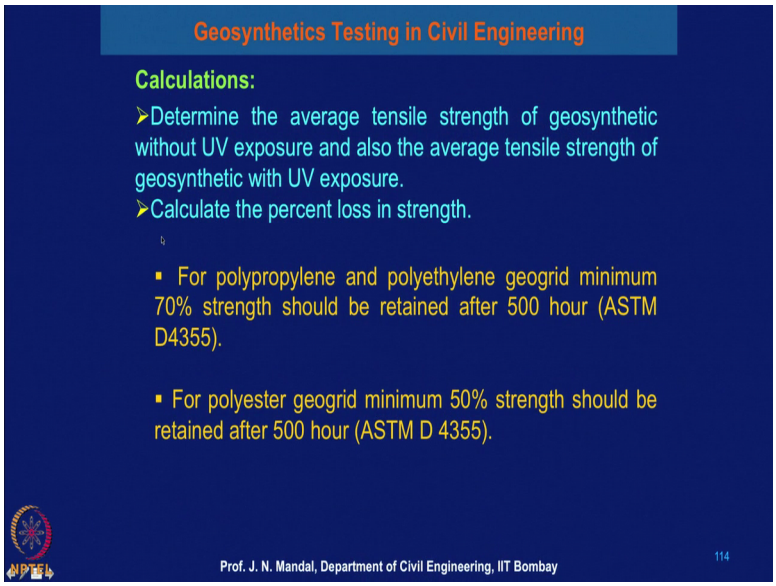
(Refer Slide Time: 03:58)



Next, the, what is the procedure for this geosynthetics material. Firstly, tensile strength of the specimen without UV exposure is determined in both machine and cross machine direction. Specimens are exposed to ultraviolet exposure in an xenon-arc device at 0, 150, the 300 and 500 per hour. It consists of 120 minutes cycle: light only 90 minutes and then water spray and light 30 minutes. After UV test, cut the strip or ravel strip tensile strips are carried out on the exposure specimen. It will show the deterioration of the exposed sample. At least five samples are tested for the UV test on both machine and the cross-machine direction.

Now, how to calculate the tensile strength of the geosynthetics material?

(Refer Slide Time: 05:24)



So, determine the average tensile strength of geosynthetics without UV exposure and also the average tensile strength of the geosynthetics with UV exposure. So, calculate the percentage loss in strength. For polypropylene and polyethylene geogrid minimum 70 percent strength should be retained after 500 hour as per ASTM D4355. But in case of for polyester geogrid minimum 50 percent strength should be retained after 500 hour as per ASTM D4355. So, one has to maintain the time and one has to know what kind of geosynthetics material you are performing the UV degradation.

So, this UV light degradation is very important because you cannot press the geosynthetics for longer time in the open sunlight. So, there is a possibility for the degradation of the geosynthetics material. Even then, some middle-east country what temperature is too high. So, you cannot give more than 14, 2 weeks or 15 days, then sometimes, these geosynthetics material turn into the dust. So, one has to be cautious and take care about the UV radiation of the geosynthetics material or what will be the vandalism of the geosynthetics material.

Next, I will discuss the Gradient ratio test and this Gradient rate test is very important and when the any geosynthetics material make clogged. Because most of the kind geosynthetics material also used as a drainage and the filtration and it is flow related problem. For example, if you wanted to use the geosynthetics material as a drainage

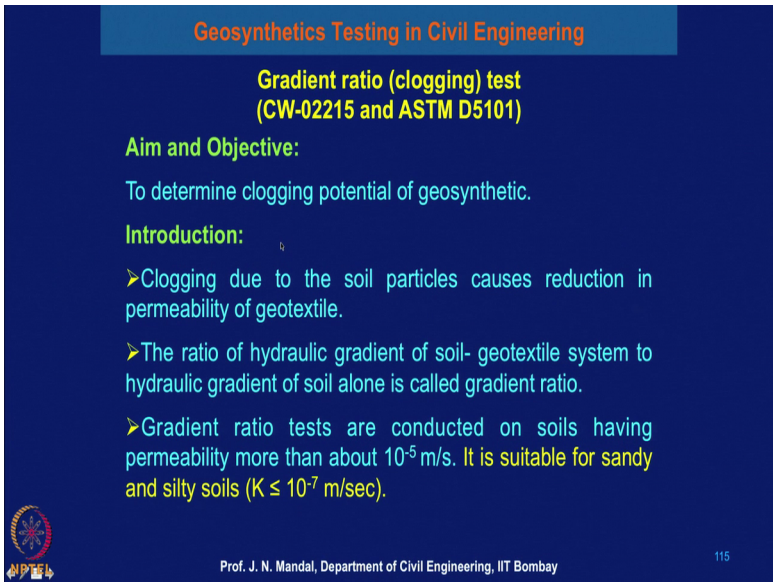
material, then there is a possibility of the clogging between the soil and the geosynthetics material.

Then, the drain will be chocked and there will be no flow as it happen in the conventional method. As we do in the conventional method you excavate and then, you fill up with a good quality of aggregate compact it and after a passage of time that because the surrounding of the good (Refer Time: 08:26) material, there is a clay. So, there is a possibility for the choking of the drainage.

So, instead of this conventional method if you can place a layer of geosynthetics material surrounding the good quality of aggregate, then there should not be any chocking and there should not be any clogging of the geosynthetics materials. Then flow will be perfectly all right.

So, for this purpose what we need that what will be the gradient ratio what kind of the material you should select and what should be there gradient ratio of the geosynthetics material that is very important to us. So, for example, that if the gradient ratio greater than 3, you will be able to tell this is clogged material. So, you can make use.

(Refer Slide Time: 09:30)



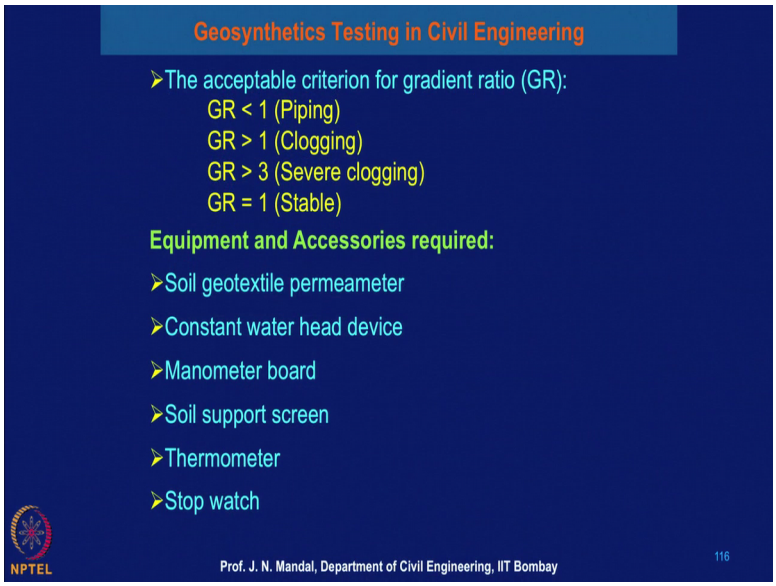
So, now I will talk about the gradient ratio. So, here the objective is to determine the clogging potential of geosynthetics. In introduction clogging due to the soil particle cause reduction in the permeability of the geosynthetics material. The ratio of hydraulic

gradient of soil to geosynthetics system to hydraulic gradient of soil alone is called gradient ratio.

So, gradient ratio test are conducted on soil having the permeability more than about 10 to the power minus 5 meter per second. It is suitable for the sandy and silty soil for the coefficient of the soil should be less than equal to 10 to the power minus 7 meter per second.

Now, this gradient ratio if it is a less than 1; then you can say it is a piping.

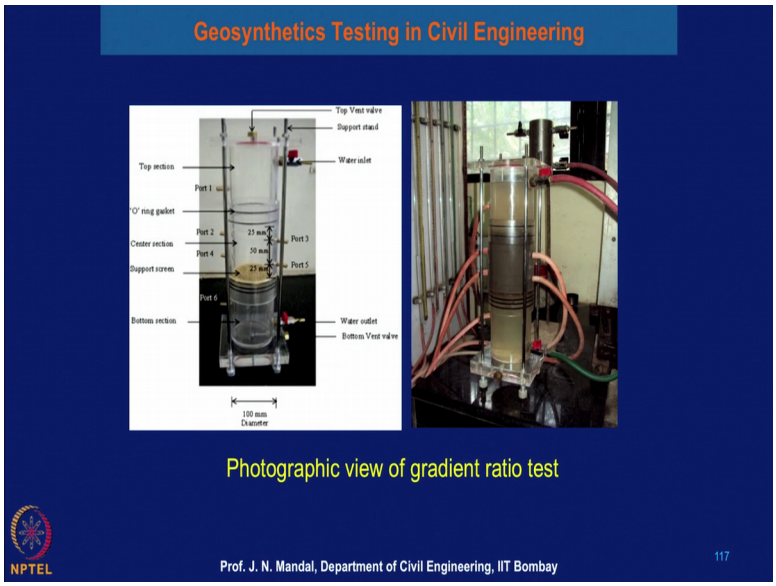
(Refer Slide Time: 10:32)



This is the acceptable criteria for gradient ratio. If gradient ratio greater than 1, you can see it is clogging. If the gradient ratio greater than 3, you can say it is a severe clogging. If the gradient ratio is 1, then you can stay stable. To perform the test you require now what will be the equipment and the accessory. So, you require Soil geotextile permeameter, Constant water head device, Manometer board, Soil supports screen, Thermometer and Stop watch.

So, I will show you that what is the type of the equipment?

(Refer Slide Time: 11:14)

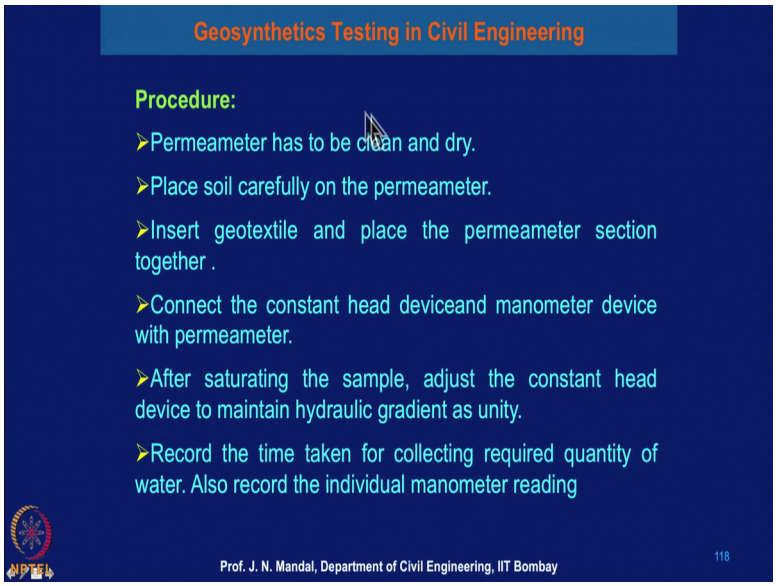


And this is the equipment already is developed in our laboratory here. This is photographic view of the gradient ratio. This is this is the gradient ratio and geosynthetics material is placed somewhere here and the soil and at a different different parts, I will show you in detail about the photometric gradient ratio of the soil sample.

For example, that here, here, here this is the. This is the devices, which is 100 millimeter in diameter and this is the bottom; this is a water outlet here; this is a bottom vent valve. And there is a port; this is port 1, this is port 2, this is port 4 and this is port 3 and this is port 5 and in between the distance between this to this port 3 and 5 is 50 millimeter and this to this port is about 25 millimeter and this is the water is inlet.

This is the top section and this is the o ring gasket. This is the centre of the section. This is a support screen and this is the bottom section. And from the support stand this is the support stand and top vent valve is here and. So, this is the schematic view of the gradient ratio test.

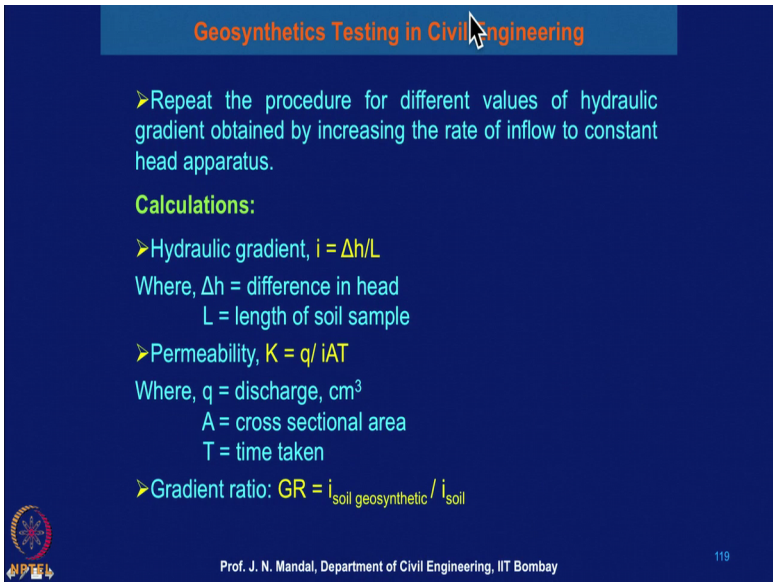
(Refer Slide Time: 13:05)



Now, what is the procedure to perform the test? So, permeameter has to be clean and dry. Place the soil carefully on the permeameter. Insert the geotextile and place the permeameter section together. Connect the constant head device and manometer device with permeameter.

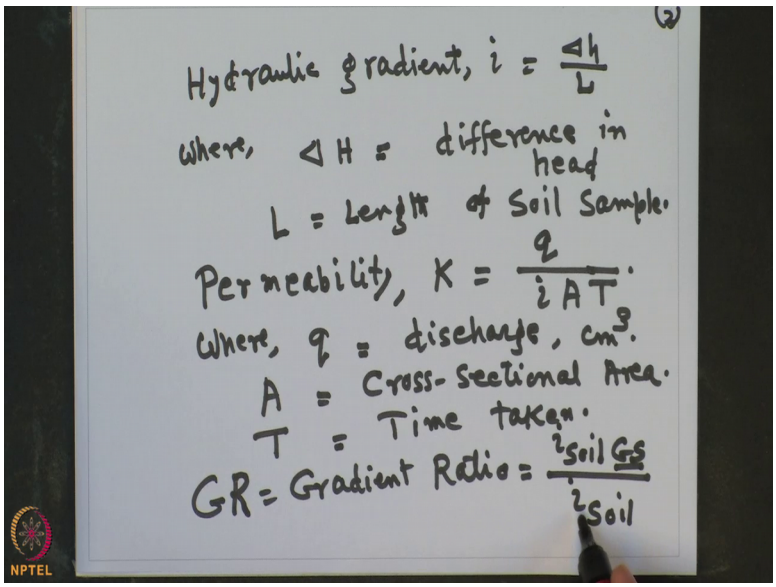
After saturating the sample, adjust the constant head device to maintain hydraulic gradient at unity. Record the time taken for collecting required quantity of water. Also record the individual manometer reading. So, here one point you have to be remember that hydraulic gradient should be 1 and this flow will obey the Darcy's Law. Now you have to repeat the procedure.

(Refer Slide Time: 14:22)



For different value of hydraulic gradient, obtained by increasing the rate of inflow to a constant head apparatus; for example that you have to calculate this gradient ratio.

(Refer Slide Time: 14:49)



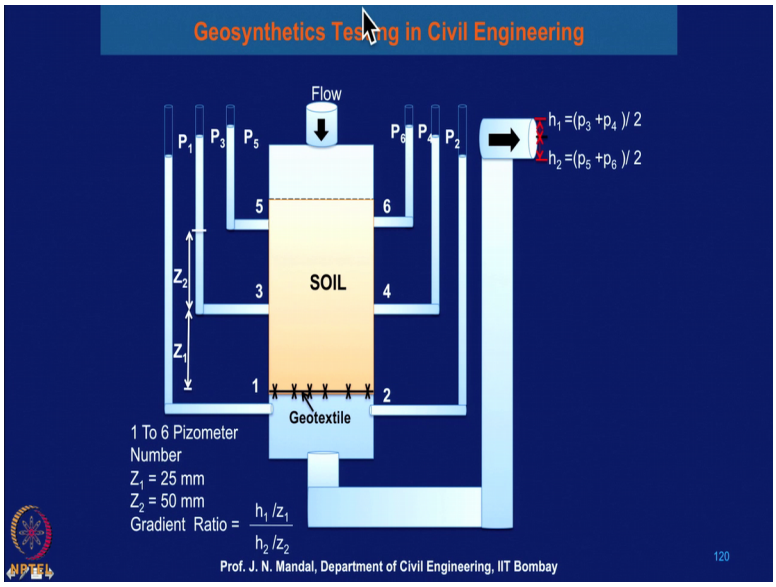
So, here I am showing you some calculation. So, hydraulic gradient, gradient that is i is equal to delta h by; where, delta of h is equal to difference in head and L is the length of the soil sample; L is the length of soil sample ok. And permeability; Permeability, K is equal to q divided by i into A into T; where, q is equal to discharge; q is equal to

discharge that is centimeter cube and A is cross sectional area cross-sectional area and T is time taken. So, this is time. So, this is taken.

So, gradient ratio if you designated at GR which is called the gradient ratio. So, gradient ratio will be i of Soil geosynthetics GS divided by i of soil. So, you can determine that what should be the i of Soil geo synthetic and what is i of soil? Then you can determine, what should be the gradient ratio of the geosynthetics material.

I will show you some view of this.

(Refer Slide Time: 17:23)



And here, you can see that these all are port and this is the soil sample geosynthe synthetic material is here and this is 1, 1 2 3 4 5 and 6. So, these are pizometer number. So, you can determine what will be the P of 1 here, here. Then, this is P 3 and this is for P 5; this is for P 6; this is for P 4 and this is for this is for P 2 ok. And this distance from here to here Z 1, which is 25 millimeter and from here to here Z 2 is about 50 millimeter.

So, gradient ratio you can calculate knowing the value of h 1, h 2 and Z 1 and Z 2. So, h 1, add this port will be equal to this is P 3 plus P 4 divided by 2 ok. P 3 plus P 4 divided by 2 and here h 2 is equal to P 5 plus this is P 5 plus P of 6 divided by 2. So, you know what is h 1 and you know what is h 2 and you know it is fixed that Z 1 and Z 2. So, you can calculate the gradient ratio; that means, is equal to h 1 by Z divided by h 2 by Z. So, Z 1, Z 2 will it fixed, only you can measure what should be the h 1 and what should be

the h 2 from the pizometer and then, you can determine that what should be the gradient ratio of the geosynthetics material.

And if the gradient ratio is greater than 3, then you can say that this is the clogged material. So, one has to be taken careful about the proper selection of the geosynthetics material for the application of the drainage and the filtration and particularly also for the erosion control.

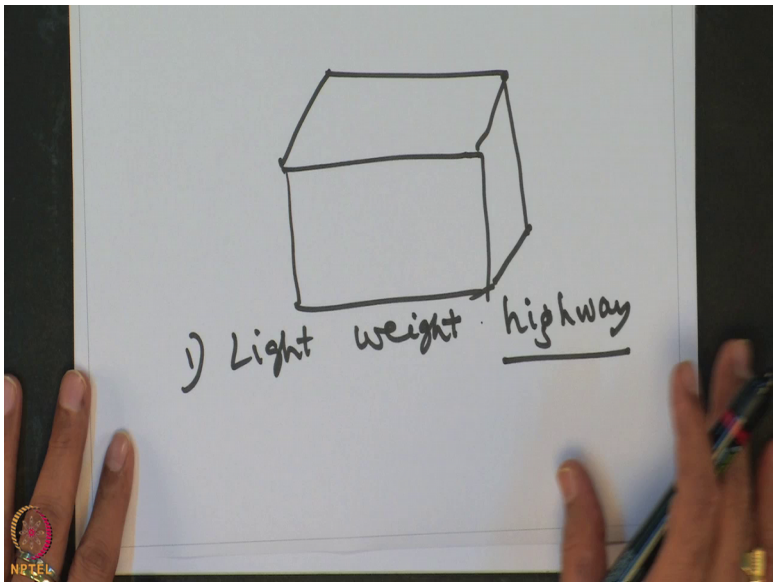
On the one side, you should know that what should be the particle size distribution of the soil and on the other hand, you should know what should be the gradient ratio of the geosynthetics material. So, knowing this gradient ratio value; so you have to be select that proper kind of the geosynthetics material which is clogging free, that is why this is more important to know the value of the gradient ratio and how to evaluate the gradient ratio of the different types of the geosynthetics material.

So now, we will discuss the Geofoam material. So, geofoam material, it is in textile term called the expanded polystyrene material or it is called the EPS. And in general, we talk about this material as a thermocol what you take a cup of tea or coffee. So, this geofoam material in geotechnical engineering term is a super light material. Its density is 100 time less than the density of the soil and this geofoam material, you should know what should be their different types of the property; physical property, mechanical property, chemical property etcetera that what we will discuss.

So, for the geofoam material, what should be their function? And this geofoam material is available in different size and the shape; it may be in the rectangular form, it may be in the cube form, it maybe in the hexagonal form; you may have it in the honeycomb form. So, different types of the geofoam material will be available and they are density also will vary it may be 11 to 62 or more. So, what kind of the geofoam material you should select for a particular infrastructure?

Now, what I mean that geofoam basically a block or a planer.

(Refer Slide Time: 23:02)

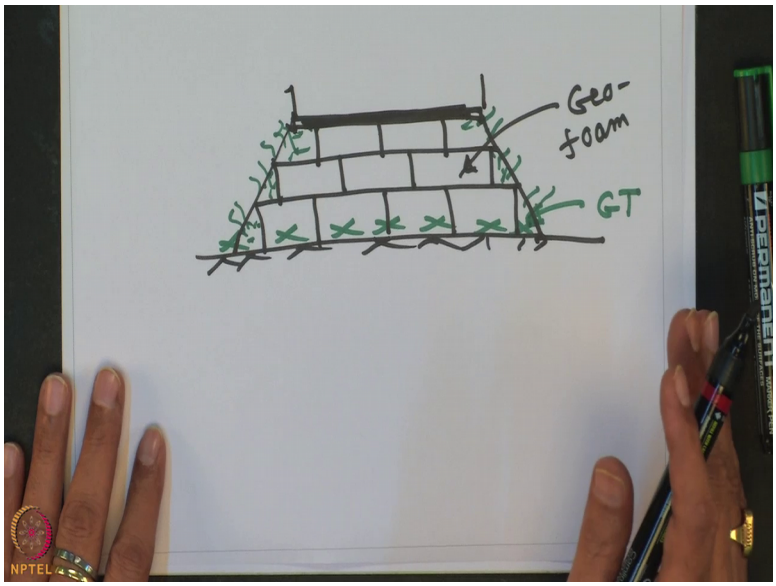


So, it is like a block or a it is like a block you know in the rectangular shape or any shape block or the planer a rigid cellular foam. Volumetric material used in geotechnical engineering application. So, this material is primary function is a lightweight.

So, this is lightweight; one of the function is the lightweight and this lightweight material can be used in the highway. You can use this geosynthetics material in highway or for the construction of national highway or the rural highway or any construction (Refer Time: 23:52) on the soft soil. For example, you wanted to construct a (Refer Time: 23:58) on the soft soil.

So, where there is a car city, you have a good quality of the aggregate. So, you do not need the good quality of the aggregate and your construction will be very fast and time is very less. You do not want to do need any (Refer Time: 24:18) of the ground improvement system. You can place the geofoam material in the form of the block on the very soft soil.

(Refer Slide Time: 24:30)

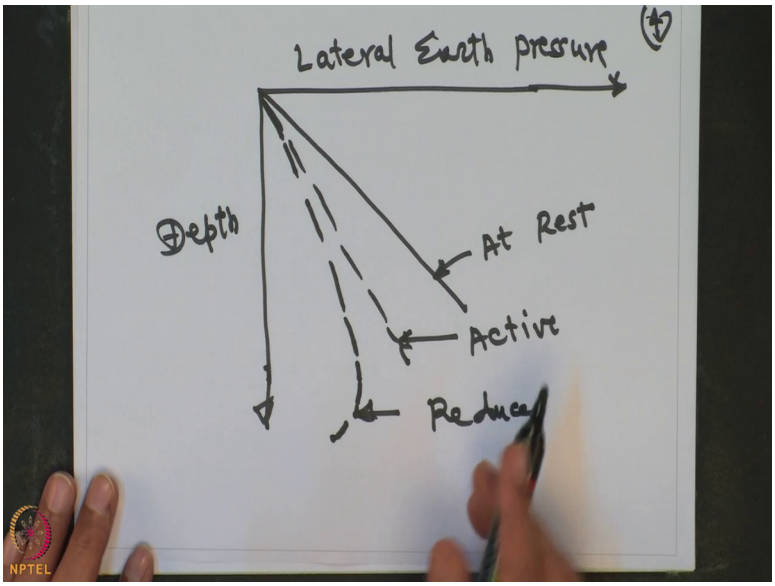


So, it was like these suppose if this is the ground surface ok. You can place the 1 layer of the geotextile material here. This is geotextile material GT and you can construct the embalmment on the very soft soil; you do not need any kind of the compaction. So, this is a block. So, this is this is the geofoam block. This is the geofoam block.

This is what you call the geofoam or expanded polystyrene material and this person you can fill up with the soil and the grass can grow. So, it looks greenery; both the sides the grass can go and as for the valve you can place on the concrete or as per the valve you can place on the top. So, you can make this a embalmment using the geofoam material. It is super light material is density is hundred time less than the soil.

So, this is one kind of the application of geofoam in the highway. So, here the lightweight is a one of the function. Now, you can use this material for compressible inclusion; compressible inclusion behind the retaining wall. So, the geofoam material, we can use back of the retaining wall. So, in that case there will be a substantial reduction of the pressure on the wall. So, how that pressure can be reduced due to the application of the geofoam material where geofoam material act as a compressible inclusion.

(Refer Slide Time: 26:57)



For example that if you draw a relationship; suppose this is the lateral. This is Lateral Earth pressure. This is lateral Earth pressure and this is the Depth ok. You know linear, when it is at rest; this is a linear and when it is active. So, this is active, it is less than the at rest condition; but when you use the geofoam material. So, it should be reduced, this is reduced. So, this is conceptual lateral earth pressure distribution under different insitu space condition. You know what is K? K is equal to sigma h sigma b; you know what is K 0; you know what is K active; you know what is K passive.

And generally, this is you can see there is arching; formation of the arching and that is why it is reducing and most of the cases back of the retained wall. It fill at the middle of the wall. Majority case fail in the infrastructure application and fill of the drain for soil retaining wall due at the middle of the wall and apart from that, this geofoam material is also act as a thermal insulation. And also another function which is drainage and also is another function also as a noise barrier, you can use geofoam material as a noise barrier.

But in case of the thermal insulation when there is a difference in the temperature or any storage or any industrial building or any garage or any shelter dwelling or any refrigerator below the ground, there is a possibility of the temperature differences and for the temperature differences what we conventional method most of the time? We use the aggregate, we use the concrete and there what temperature will be the more; but

alternative to the alternative to the aggregate or the concrete, one can make use of the geofoam material and it is a very good as a thermal insulator.

So, we will also evaluate how to determine the thermal insulation and how it work and what will be the difference in the temperature because difference material as a different kind of the thermal insulation. So, what kind of material we should use and what will be the difference between the conventional material aggregate, brick whatever it may be concrete with respect to the geofoam material; that also we will discuss later.