Soil Mechanics/Geotechnical Engineering I
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Lecture - 02
Soil Formation

Once again welcome to this second session. In the previous session I have described basically rock formation, a rock also we have to handle as a civil engineer and of course rock mechanics there is a separate subject, there we can learn one can learn the different aspect of rock behavior and how rock will be used in different purposes, but our subject is soil mechanics and we have to handle soil and now, we will start with soil how that soil actually from transformed from rock actually and by different processes. So, soil formation from rock this is the topic I am going to start now.

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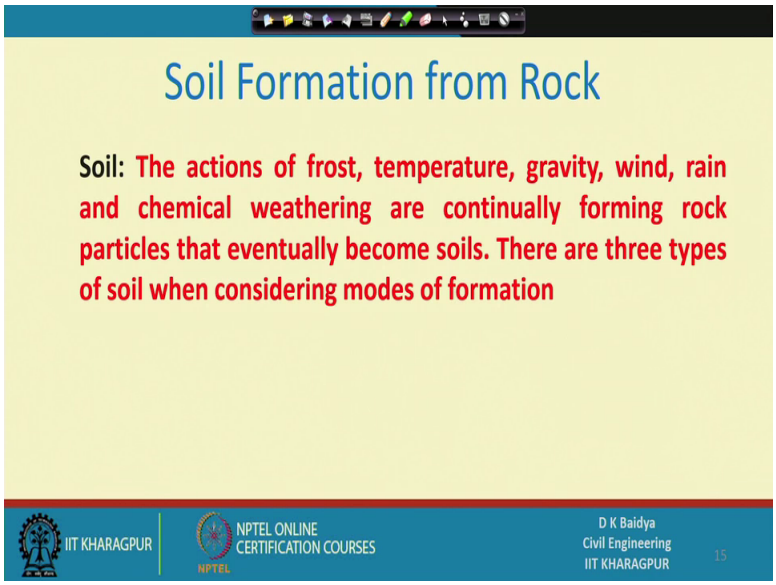

The action of frost, temperature, gravity, wind, rain and chemical weathering are continually forming rock particles and that eventually become soils.

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There are three types of soil when considering modes of formation, one is transported soil generally that under this transported soil they are gravel, sand silt and clays they are generally transported soil and most soil transported by water as a stream or river losses it is velocity, it tends to deposit some of the particles that it is carrying and obviously, when we try to deposits then bigger particle will be dropped first and heavier particles bigger and heavier particles will be dropped first and as a result on the higher reaches of a river we can get gravel and sand and on the other hand on lower or older parts silt and clays will be predominant.

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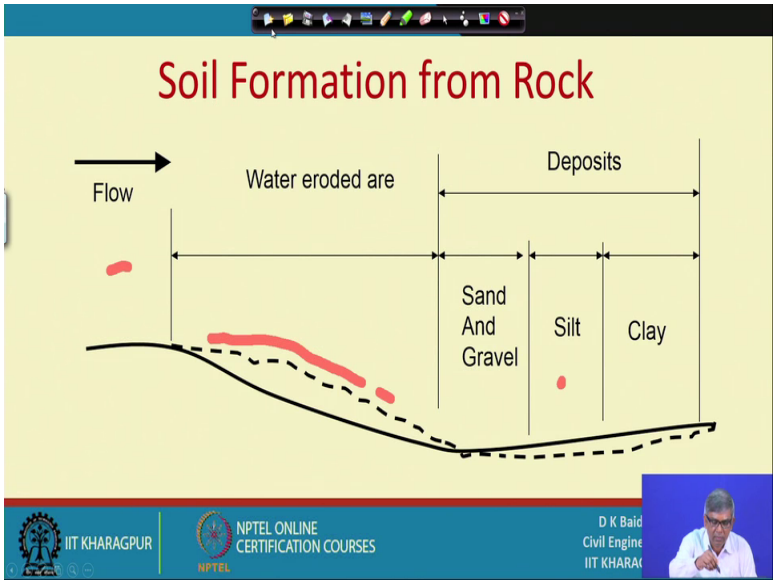

Especially where the river enters the sea or lake and loses it is velocity there we will get only silt and clay. So, I will try to show how this happens suppose this is the river flowing in this direction and this is solid this the dotted line, this suppose this dotted line was the original line of the bed of the river and while flow is taking place and obviously this side will be flow will be more and because of this heavy flow sometime this bed which supposed to be rock will be eroded and this will be travelled along with water and then when the river become differ in some to the live level ground and velocity.

Obviously it will be reduced, and because of this reduction on velocity this bigger particles sand gravels will start depositing first then later on it will start depositing silt and close to the sea it deposit actually the clay, this way actually different reaches of the river we can find sand, gravel, silt and clay . So, this is actually the formation of soil by to weathering process or and what type of weathering it is a water weathering.

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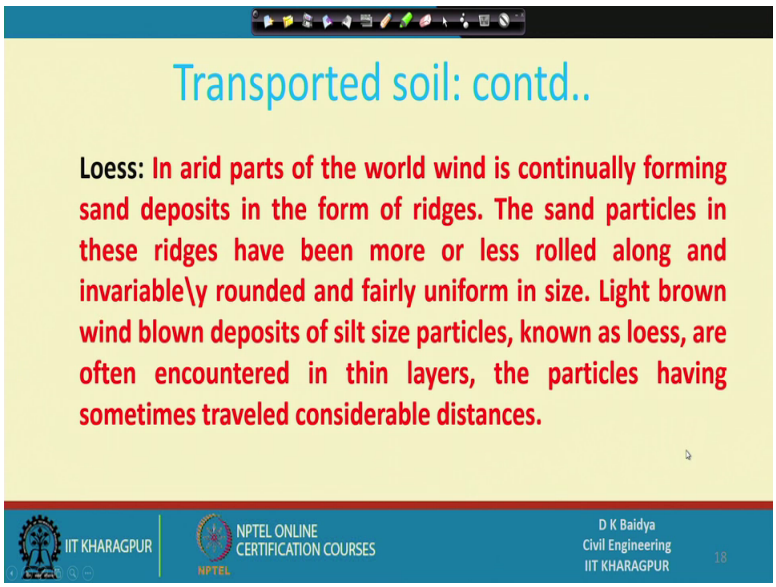

Another soil type actually is which happens actually in the a arid parts and in arid parts of the world, wind is continually forming sand deposits in the form of ridges the sand particles in this ridges have been more and less rolled along and invariably rounded and fairly uniform in size, light brown windblown deposits of silt size particles known as loess are often encountered in thin layers the particles having sometimes traveled considerable distance. So, this name is loess sometime I have mentioned the previous in the rock part also soil and rock part there also have mentioned hardpan sometime in the

some exam what is hardpan. So, some question may be there so or it may have a multiple choice type of question it will give different description and you have to find out exactly what it is. Similarly there are different soil how they are forming based on that technical name is the loess is one such soil type it is (Refer Time: 05:40) born soil and it is name is loess.

So, sometime multiple choice type of question m c q there are lot of description will four description will be given and finally, your choice to be used description will be given and then finally option will be given name of the soil and you have to find out which one is the correct one. So, loess like that some description will be there when born and all from this description one can find out that this is the loess. So, like that typical soil there are they are some name. So, one such is loess.

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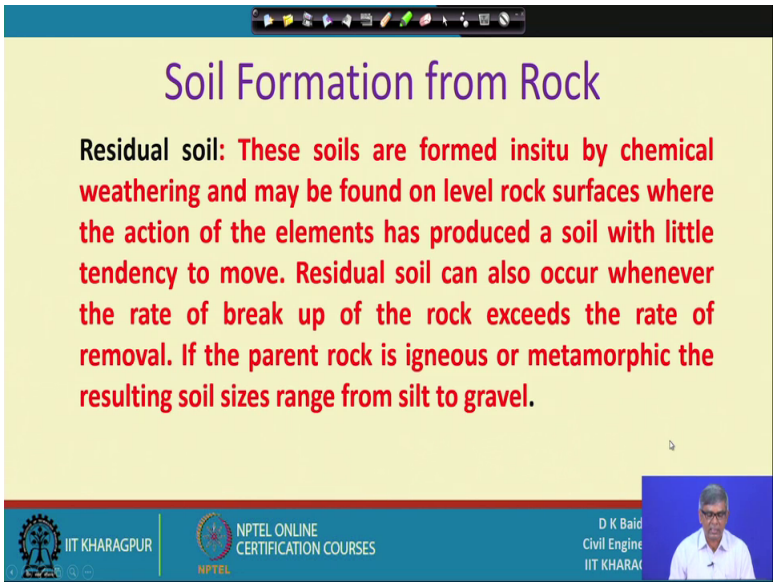

Then residual soil that is one it is with transported soil both are wind and water, they are actually transported soil and this residual soil this is another soil where this residual soil is what actually the soil will form and deposit there itself there is no movement and for this there is some process will there that is generally is chemical process. So, this soils are insitu means in the place itself where that the rock itself because of these changes transform into the soil that is residual soil. So, the form insitu that means it is in place itself by chemical weathering and maybe found on level rock surfaces where the action of the elements has produced is soil with little tendency to move that mean no movement

only because of the following changes now if it is take place because of this chemical reaction etcetera only a little movement otherwise, chemically it will be converted from rock to some soil that is residual soil. And residual soil can also occur whenever the rate of breakup of the rock exceeds the rate of removal. So, then some will be deposited there itself or so that is called also residual soil if the parent rock is igneous or metamorphic the resulting soil size is ranges from silt to gravel.

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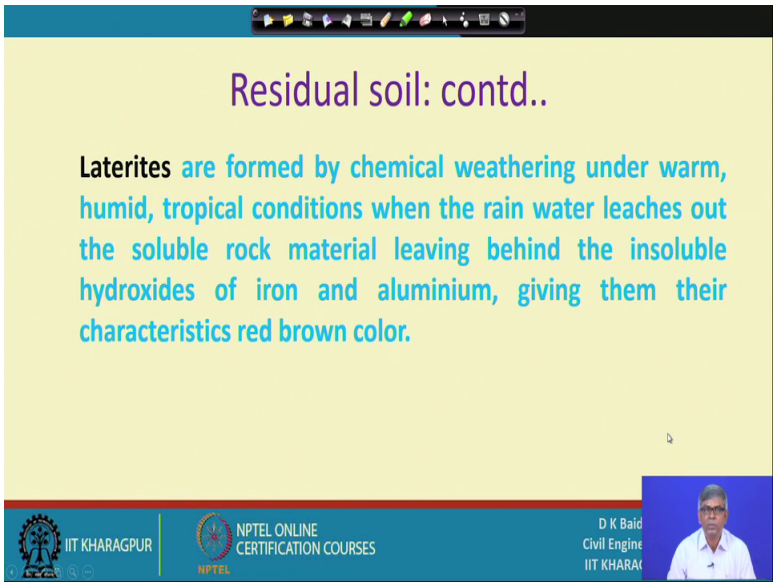

And residual soil one important residual soil is laterites, this laterites that is it is a special type of soil like loess or hardpan I have mentioned are formed by chemical weathering and warm humid tropical conditions, when the rain water leaches out the soluble rock material leaving behind the insoluble hydroxides of iron and aluminum and giving them their characteristic red brown color. So, laterite actually it is a reddish brown color and it is quite hard and it is by chemical weathering this type of soil form.

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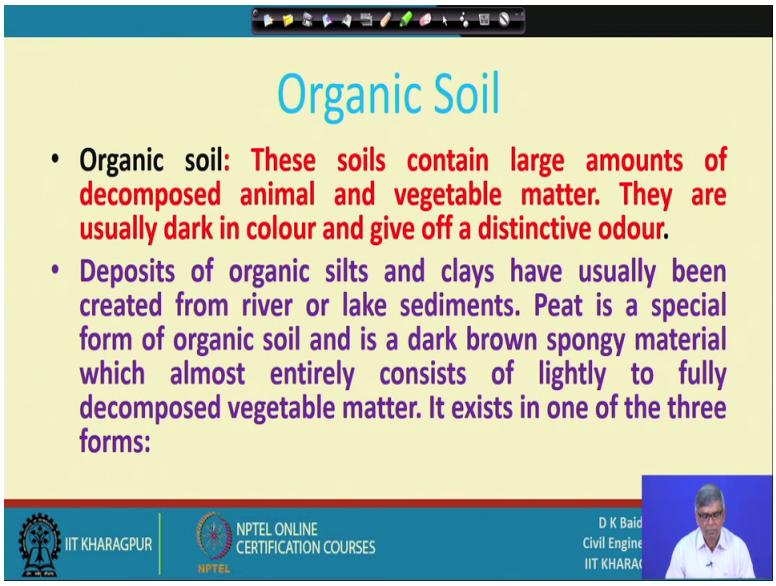

Ah then next is I have mentioned the three types of soil, one is transported, another is residual and third one is the organic soil. The organic soil this soils contain a large amount of decomposed animal and vegetable matter and they are usually dark in color and give of a distinctive odour smell from the smile itself and color one can identify whether the soil is organic or inorganic, deposits of organic silts and clays have usually been created from river or lake sediments.

Because if it is deposited in the water that then this will be converted into some silt organic silt and clay type of material for a long time if it is there, Peat is a special form of organic soil and is a dark brown and spongy material and which almost entirely consist of lightly to fully decomposed vegetable matter and it exists in one of the three forms, the organic soil can be there in the three different form completely decomposed partly decomposed something that by accordingly that according to that.

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And this is one form is fibrous the though organic soil, but is not completely destroyed it is structure original structure non plastic with the form structure only slightly altered by decay. That means the original organic is totally not altered still visible and it will be non plastic in nature and next is pseudo plastic, peat in this form still has a fibrous appearance, but is much softer and more plastic than fibrous peat the changes due to more prolonged submergence in the airless water than to decomposition the pseudo plast, pseudo plastic this is for a longer period if it is submerged that happens actually then this pseudo plastic organic soil can form.

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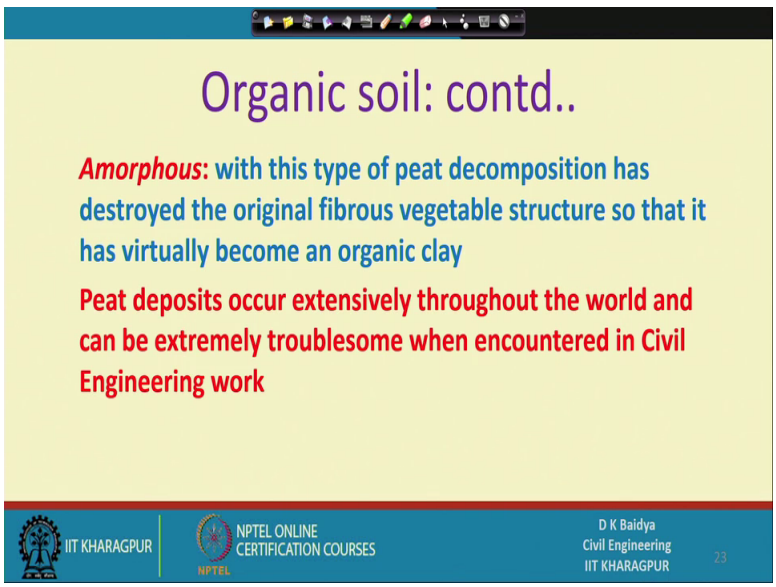

And amorphous, this type of peat decomposition has destroyed the original fibrous that means, it is complete decomposition to place and virtually become an organic clay that means, the now we are talking about gravel sand silt clay how they are different actually depending upon their size the gravel if and it is a greater than 4.75 particle size and when it is sand it is between 4.75 millimeter to 75 micron, and 75 to 0.002 millimeter is the silt and finite then 0.002 millimeter is clay. So, the amorphous organic soil is organic clay that means, it is not only decomposed the particle size become so small it is like a clay and when this organic clay form in a large volume in a particular site it is dangerous, it is behavior is very much unknown and lot of volume change will take place and because of that it has to be handled very carefully.

So, peat deposits occur extensively throughout the world and can be extremely troublesome when in covered that in civil engineering work, that means the surface we may find that soil is quite good, but maybe after 2 3 meter that may be a very thick layer of organic clay and organic clay boids is very high, of course we do not know you may not know now what is boids etcetera from the term itself we can visualize that boids means presence of boids in the soil mass definitely.

The soil is not a perfect solid it is particles and between the particles are boids and though organic particles organic clay is very fine particles and particles to particles there will be contacts and those between the particles there will be very fine boids and since a number of particles is very large then number of boids is also very large. So, ultimately the boids presence in the organic clay is very high and because of this high boid ratio it is problematic, because when we apply load then this boids will be reduced which result in the subsidence that means settlement.

So, if the in structure is if this if the structure is constructed to or a organic clay we expect a very large amount of settlement and that settlement has to be estimated otherwise the building or structure will have or face difficulty or it will not be able to give proper service. So, that is the warning that if you find anywhere the organic clay it has to be handled very carefully.

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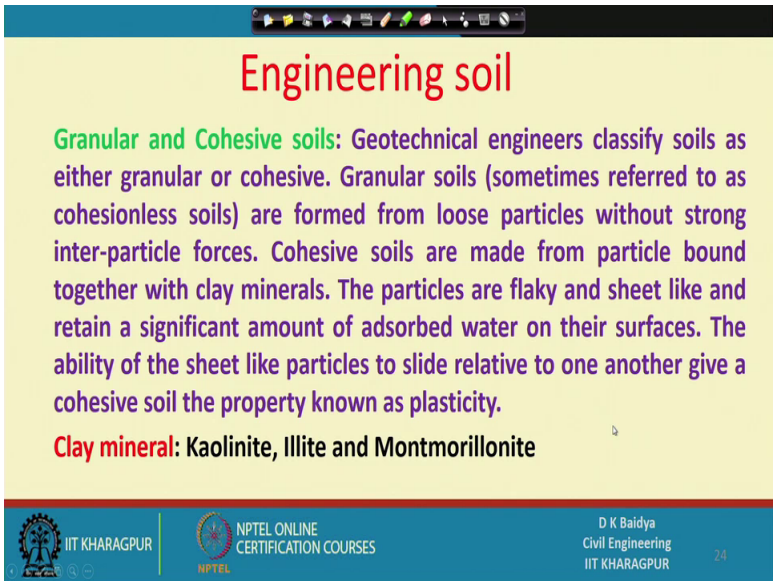

Now engineering soil, engineering soil we engineer actually classify the soil in two groups, one is granular another is cohesive. So, that is what geotechnical engineer that means, we under geotechnical group talking about soil mechanics, we consider soil as either granular or cohesive.

Granular soil sometime referred to as the cohesionless soil that between the particles there is no cohesion and formed from loose particles without strong inter particles (Refer Time: 16:21) forces the when it is a sand or this cohesive soil two particles when they are compacted through this contact between the contact of the particles they can they can do transport load and all, but since they do not have any bond then sometime it can be it is easy to separate to separate.

Cohesive soils are made from particles bound to get together with clay minerals and the particles are flaky and sheet like and retain a significant amount of absorbed water on their purposes, the ability of the sheet like particles to slide related to one another give a cohesive soil the property known as plasticity, that while sliding over one over other because of this inter particle force say that is cohesion equation we get the plasticity property in the cohesive soil. So, basically in geotechnical engineering we classify the soil into two group major group one is cohisionless and that is sand and another is or sometime it is called granular soil or cohisionless soil or sand gravel directly you can

mention and other type is cohesive soil that is where actually soil particles is very small and it consists of clay minerals basically.

And there are many clay minerals exist and most important clay mineral for which we know lot of characteristics they are kaolinite, illite and montmorillonite and out of these three kaolinite and illite is comparatively not much volume changes take place whereas, montmorillonite is a highly when it come in contact with water too much volume changes take place and more plastic. So, three different types of important clay minerals just I have I was talking about kaolinite, illite and montmorillonite and it exist in the site in different form in different combination and of course, clay mineralogy is a another separate topic we are not going in detail we will try to concentrate more on mechanics.

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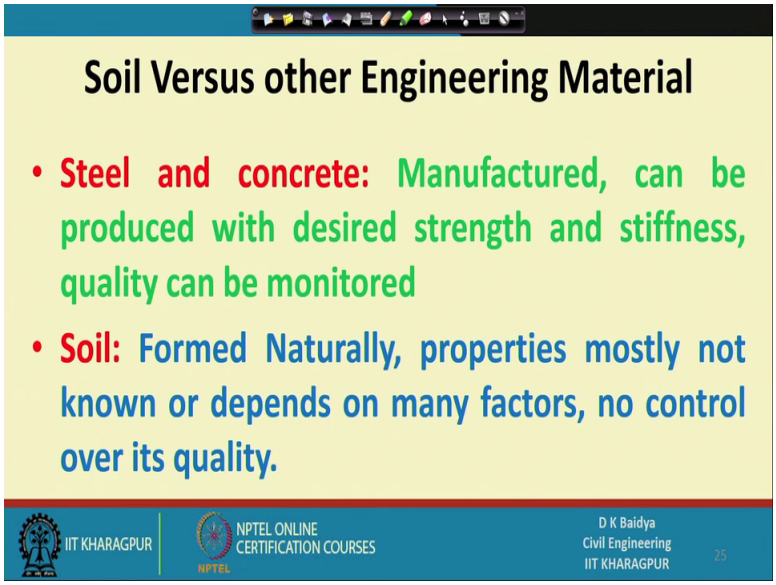

So, I will leave it here and I proceed next for, now this we have discussed rock now we have discussed soil and how agricultural engineers see the soil how geologists see the soil and how geotechnical engineers see the soil we have discussed and finally, I have mentioned that the our geotechnical engineers generally geotechnical community generally classify the soil as granular or cohisionless and cohesive and these two. Now as I have mentioned in the beginning that soil generally is a material.

So if I ask you that name a few civil engineering material and many of you mention the many material name and I am sure you will miss the soil, because you may say that it is a steal, you may say a brick, you may say a concrete, you may say fine aggregate scores

aggregate and cement many other name glass, wood, but you will you may miss that soil as material because since we are building everything on it we are not most of the time we are not buying separately we may miss that that as tell the soil as material, but it is a very much civil engineering material. In fact, when you will buy a land and plan for a construct constructing an infrastructure and you have to see the soil quality and if the quality is not up to the mark then you will not be able to build directly on that.

And in that case what you have to do either you have to remove the poor soil from the surface and bring some good soil before constructing the infrastructure or facility or you can apply various technique to improve the soil to our desired requirement. So, though soil is very much a material, that means you have to know the understand the behavior you have to know many other properties before doing any activities on the soil.

So if this question comes then you should not miss the soil as a civil engineering material in fact this is the major material civil engineering material. So, now so what is the difference between other soil versus other engineering civil engineering material if I see the difference the broad difference is like that, steel and concrete is the most important civil engineering structure perhaps superstructure we built with this only and this can be manufactured both steel and concrete and can be produced with desired strength and stiffness and quality can be also monitored.

So, this is the other civil engineering materials whereas, when it is soil generally formed naturally I have already explained and property is mostly not known or if it is known maybe qualitatively known and it depends on many factors and no control over it is quality that means, I need good soil so I cannot say that a particular site become a good site. So, if I want to make a good site then I have to apply some technique to make it good, so that means since soil is a natural material so it is you have to understand the soil before using it.

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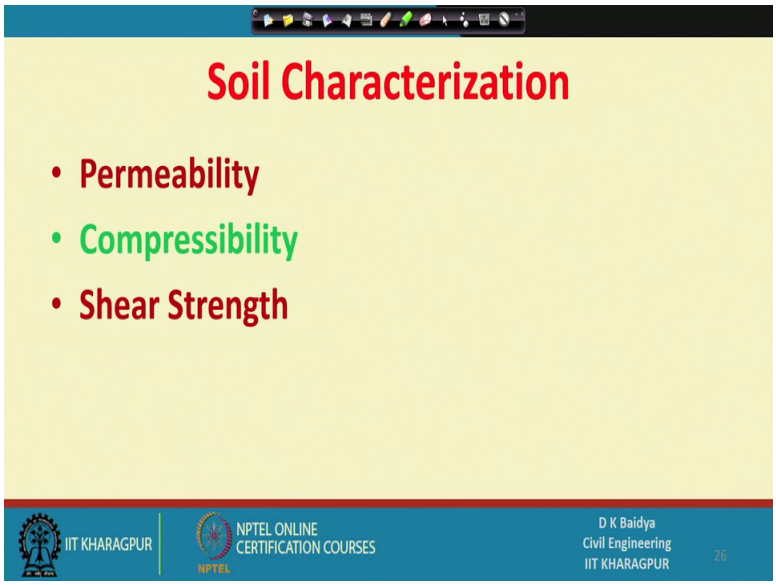

So, for understanding this soil this basically this soil entire soil can be characterized mainly by three properties, one is permeability another is compressibility and third one is the shear strength. This three things actually have to see in the different ways in by soil mechanics courses permeability means what actually the as I have mentioned that soil is a porus media and through the interconnected boids the soil can pass through that means, soil can pass through that soil.

The ability to or ability to move water through the soil that is actually nothing but permeability and we do not deserve the soil to be highly permeable some area some places we expect permeable, but most of the construction site we do not expect it is too much permeable. So, permeability is a most of the place most of the cases it is a negative characteristics so that means, if you want to choose a site and permeability characteristics also has to be understood and it is has to be within our desired expectation.

An another second part is the compressibility this is also another very important characteristics of soil, compressibility means when applied load how much it will compress or subside suppose you apply load onto the ground surface whether that it will just react without any deformation or react and with some deformation so that actually give you the compressibility property for example, if I build a structure on sand or gravel it is compressibility will be something and if you built on a structure on a on a clay soil

then it is compressibility will be different. In fact, when the compress that means, if you build a structure on sand that whatever subsidence is required or it will undergo it will happen in a very short time whereas, if we build a structure on a clay soil that subsidence will happen on a over a long period and how it happens that mechanism in fact will understand through the soil mechanical compressibility mechanism or compressibility characteristics of the soil that will come later on.

So, like permeability characteristic you have to understand similarly compressibility; that means, if you apply a load how it react how much it will subsedent I have subside that has to be understood and through proper mechanics we will discuss that also subsequently and last and most important perhaps is the shear strength that means, the soil should be strong enough like, if I take a rolt and then I can pull it and if I pull it then it will elongate and sometime it will fail and it will fail by tensile strength similarly if I compress it may also fail it will fail by compressive strength.

So, like that the steel or fail basically in the strength (Refer Time:27:27) since it is a good strength(Refer Time:27:29) we use wherever strength (Refer Time:27:32) will occur, but in soil generally soil fail in shear strength and the you have to determine how strong is the soil in terms of shear strength, if the some soil have very poor in shear strength, some soil will have a very high a very high in shear strength.

For example, generally granular soil will have better shear strength than cohesive soil and so that means, and we have to understand the permeability characteristic, we have to understand compressibility characteristic we have to understand the shear strength characteristic and again under this what are the parameters involves, how to determine those parameters all those things subsequently one by one we will discuss maybe in the subsequent lecture.