

Soil Mechanics/Geotechnical Engineering I
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Lecture - 01
Rock Cycle

Good morning. I welcome you to this particular course Geotechnical Engineering or Soil Mechanics. In civil engineering we have five distinct group and you can see you know so that is structural engineering, geotechnical engineering, water resources engineering, transportation engineering and involuntary engineering.

Out of these geotechnical engineering is one of the groups, and under this almost every undergraduate course you will have two compulsory courses: one will be soil mechanics one sorry one will be soil mechanics and most of the places this is the name, and some places it is having the name geotechnical engineering 1. And second course compulsory course will be the foundation engineering. And though right from beginning I will be if you look the history in civil engineering, the structural engineering is the dominant section, and geotechnical engineering was developed quite slow in fact, may be after 60s he started doing reasonably well, but in our country it was still little late and now it is of substantially developed.

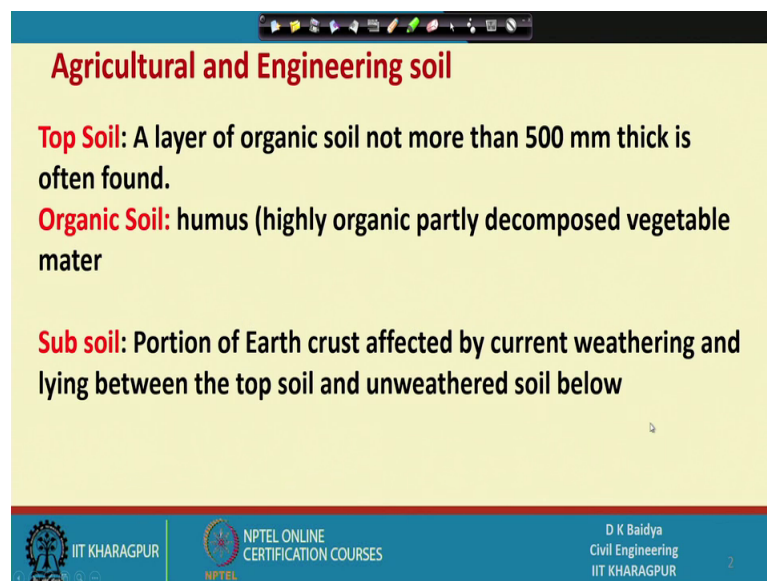
But whatever civil engineering infrastructure we think about finally it has to go on to the soil. So, soil mechanics and foundation engineering is supposed to be a very important subject. And this is whatever structure we think about the finally, it has to go to the foundation. So, you have to design the foundation for building, foundation for retaining wall, foundation for dam many other things.

And so we have to design those foundation elements and for the design of those foundation elements, the bases is the soil mechanics. The until unless you know the soil mechanics, you will not be able to design the foundation. Then also soil mechanics is the tools for designing the foundation elements, and this soil mechanics we are we will try to cover under this course the entire soil mechanics and we would have number of modules, and this soil initially unlike other structural material, which actually can be manufactured in the industry in the factory, its quality can be controlled whereas, the soil is naturally

developed and its property is generally cannot be controlled by us whatever available we have to use it.

And sometime if it is not suitable, then we need to go for ground improvement etcetera there are some other subject will be there or sometime in the foundation engineering, different ground improvement techniques will introduce. Otherwise in this course only we will try to talk about soil mechanics. And since soil is actually behave differently in different condition or in different if the composition is different. So, if the composition is different or if the moisture content is different or many other series the (Refer Time: 04:33) is less or it is a older deposits. So, depending upon all those situation, the it is behavior also changes. So, because of that the first we will look at the origin and classification of soil; if you can classify the soil you will be able to tell many thing about it.

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Agricultural and Engineering soil

Top Soil: A layer of organic soil not more than 500 mm thick is often found.

Organic Soil: humus (highly organic partly decomposed vegetable mater)

Sub soil: Portion of Earth crust affected by current weathering and lying between the top soil and unweathered soil below

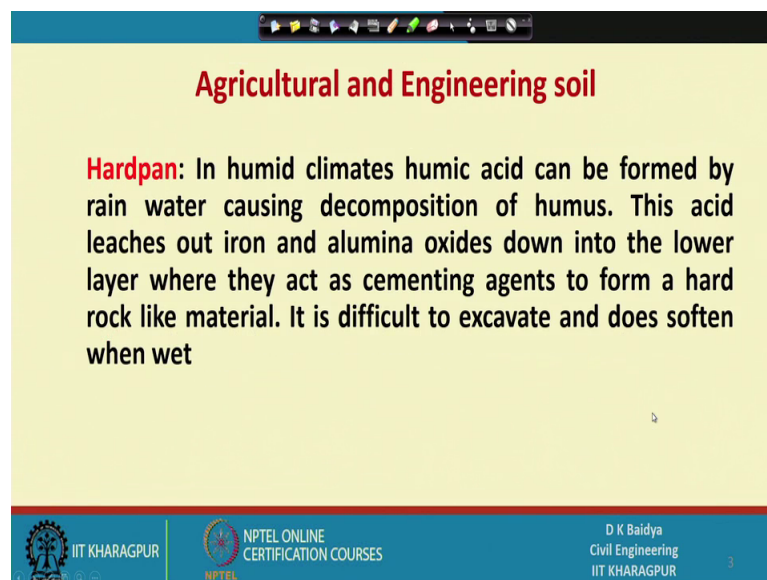
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So, with this intention we will we will start this presentation of this soil mechanics course. So, first of all I want to again soil actually is a general term, but this soil again the user will be three different user will be there, there will be executed agricultural people they use soil in a different way, they think they considered its nutrition values and many other factors, whereas geologist also consider soil as something different and as engineer we consider as a material, and its strength is most important parameter and strength and many other things, which we will discuss one by one.

So, initially we will look at this agricultural and engineering soil just in general, and you can see if you look at the site then every site will see there will be a layer of organic soil and not more than 500 millimeter thick that is there and that is considered as topsoil. And this topsoil mostly will have humus that is decomposed vegetable matter. And after that we will have sub soil that is actually portion of earth crust, affected by current weathering and lying between the top soil and armed without soil below, this is the subsoil.

So, these subsoil these are the different ways actually agricultural people can classify, but when we this classify the soil, definitely you have to classify differently and that we will see that later on.

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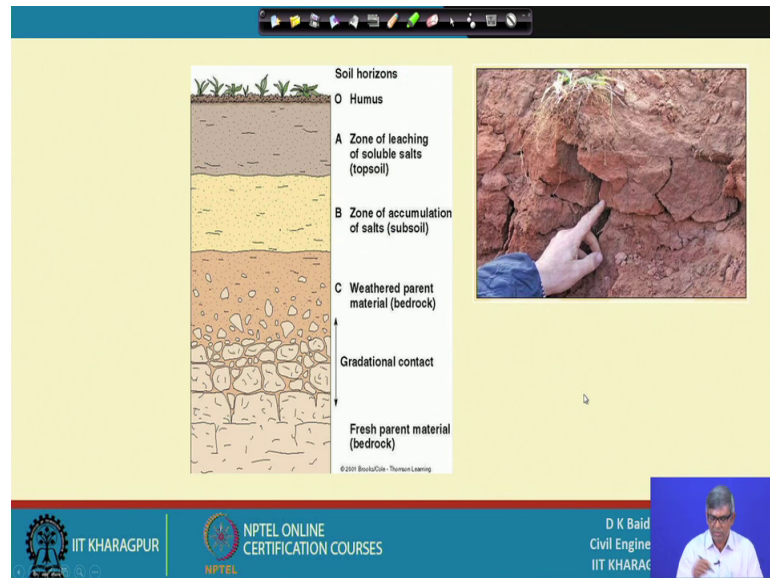
Agricultural and Engineering soil

Hardpan: In humid climates humic acid can be formed by rain water causing decomposition of humus. This acid leaches out iron and alumina oxides down into the lower layer where they act as cementing agents to form a hard rock like material. It is difficult to excavate and does soften when wet

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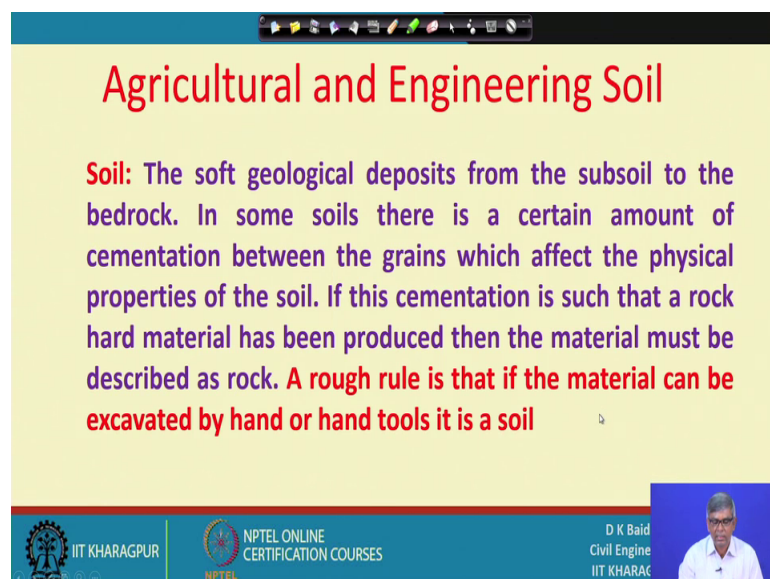
But, at this point there is another layer in between sometime present that is called Hardpan. And that hardpan actually is a in humid climates, humic acid can be formed by rainwater causing decomposition of humus and this acid leaches out iron and aluminum oxides down into the lower layer, where they act as cementing agents to form a hard rock like material. And it is difficult to excavate and does soften when wet.

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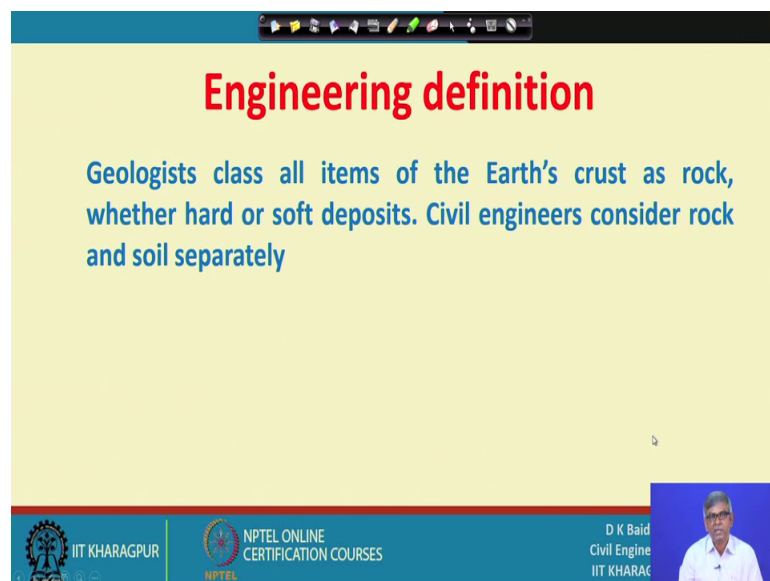
So, this is the hardpan and this hardpan is very hard actually, and this we can see how or where they form typically and whatever I said the top soil subsoil and all, these are the different this is actually top soil humus and all will be considered this is actually subsoil, and these are the portion actually up to this, this is actually sub soil zone. And from the top soil to this sub soil zone when their hemi cut is performing and it is leaching out at depositing somewhere here, that hardpan formed. And this typical hard for hardpan can be look it will be look like this and if you will excavate and some places the hardpan will be visible and which is like this.

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And then agricultural engineering soil once again the soil according to their classification. The soft geological deposits from the subsoil to the bedrock, which I have shown in the previous slide, in some soils there is a certain amount of cementation between the grains which affect the physical properties of the soil. And if this cementation is such that rock like material is produced then that should be taken as rock. And a rough rule is that, the material can be excavated by hand tools or hand then that will be treated as soil.

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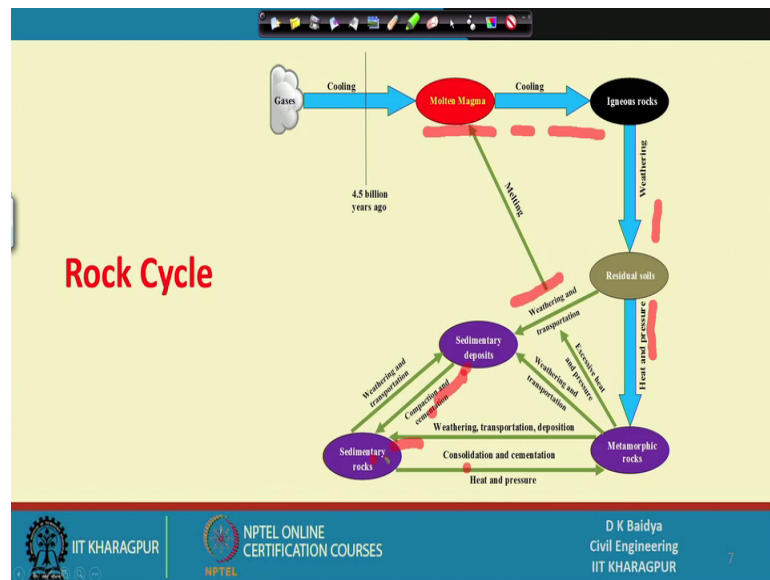
Engineering definition

Geologists class all items of the Earth's crust as rock, whether hard or soft deposits. Civil engineers consider rock and soil separately

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And engineering definition, the geologist actually crust all items of the earth crust as rock whether hard or soft deposits. And civil engineers whereas, civil engineers consider rock and soil separately.

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And this rock and soil actually rock also there are different types of rock possible and how rock forms, and then from the rock how soil forms, these are all different situation and they are process and this is the typically I have projected here this is rock cycle, you can see that the volume a early stage it was a gas actually, and by cooling it became molten magma and upon cooling of molten magma the igneous rock were formed.

And this igneous rock this is the way they are moving this way it is moving igneous rock and then after weathering, because of the weathering of igneous rock the residual soil can form this is moving in this direction. And again residual soil if it is by weather weathering and transportation, and there can be a sedimentary deposits can form and that sedimentary deposits again further by compaction and cementation sedimentary rocks and for. So, this is the way it can go from molten magma by cooling igneous rock, again weathering it is a residuals rock residual soil, from residual soil the transportation and weathering sedimentary deposits and then by compaction and cementation it is raising to sedimentary rock.

Now, again instead of following this path, it can follow this path also if it goes this way by heat and pressure, then metamorphism took place or metamorphism happening happened and because of that metamorphic rock also can form. And again after metamorphic rock or metamorphism and formation of metamorphic rock this can again

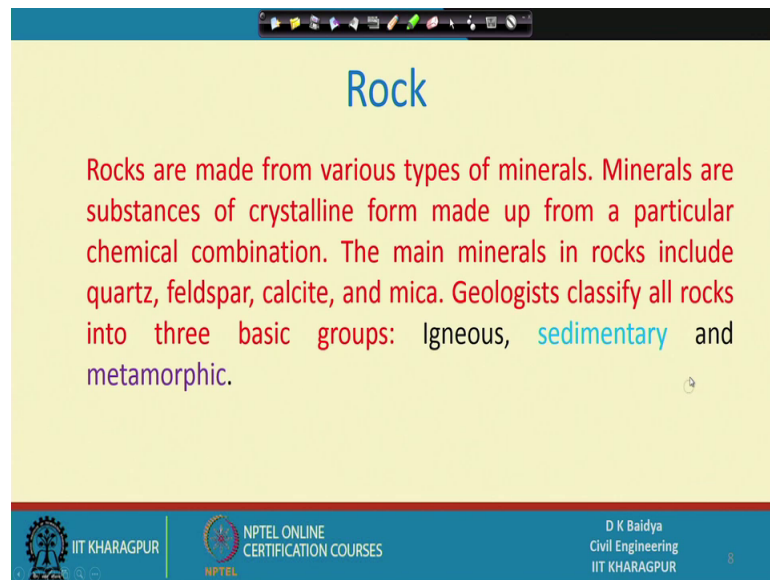
further weather and transported are deposited and then that is actually in this way it can form sedimentary rocks. And so, this is the one path is this too.

So, igneous metamorphic sedimentary or igneous directly sedimentary through residual sedimentary soil and all, and again igneous metamorphic and sedimentary this is the two ways it can be formed. Again after sedimentary rock also it can happen the consolidation and cementation heat and pressure, then again metamorphism can happen and it can reach to metamorphic rock and here also this reversal also can happen, here actually by cementation and compaction it leads to sedimentary rocks, but again same way, in this way weathering and transportation sedimentary deposit form. And again it come back to sedimentary rock.

So, this way the different rocks that igneous metamorphic and sedimentary rocks can be seen in the your any site if you go deep, then we may find somewhere igneous rock somewhere you may find metamorphic rock, somewhere you may find sedimentary rock. So, these are the rock cycle and also I missed another point this metamorphic rock also directly can weathered and transported and then that will be sedimentary deposit will form and then further compaction and cementation sedimentary rocks also can work. So, this is also another way. So, the cooling molten magma igneous rock metamorphic, metamorphic to transportation weathering sedimentary deposit and sedimentary rock, or directly here by weathering and transportation directly to the sedimentary rock.

So, this is the typical rock cycle actually and if you discover excavate and go deep at any site, we may find this type of rock some site you may find igneous rock, some site you may find a metamorphic rock, some site you may find sedimentary rock.

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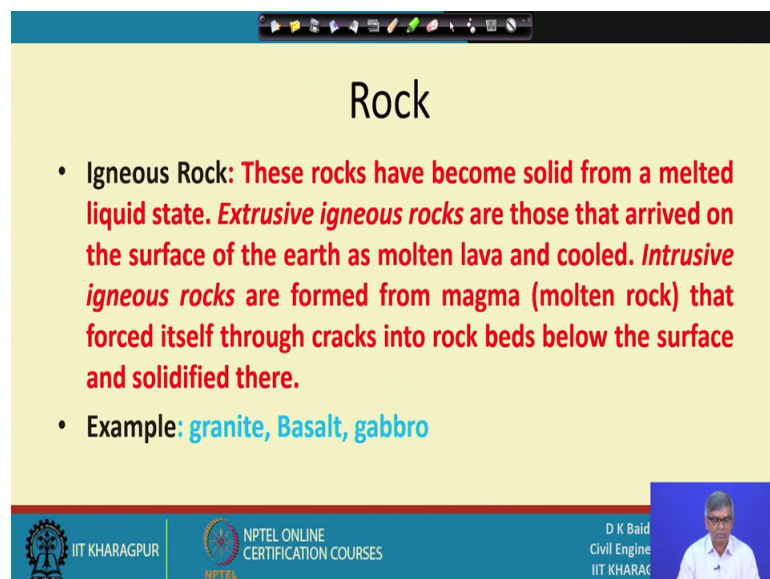
Rock

Rocks are made from various types of minerals. Minerals are substances of crystalline form made up from a particular chemical combination. The main minerals in rocks include quartz, feldspar, calcite, and mica. Geologists classify all rocks into three basic groups: Igneous, sedimentary and metamorphic.

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So, rock actually rocks are made up from various types of minerals, and minerals are substance of crystalline form made up from a particular chemical combination. The main minerals in rocks generally find are quartz feldspar calcite and mica. And geologist classify all rocks into three basic groups, they are igneous rock sedimentary rock and metamorphic rock which I have already shown in the rock cycle. Now we will started to see the characteristics of each rock and a few names known rocks under each category we will try to discuss one by one.

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Rock

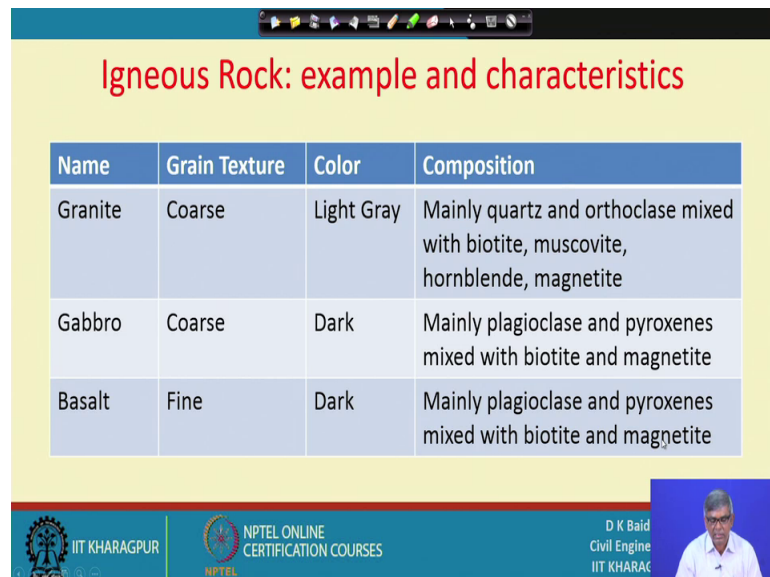
- **Igneous Rock:** These rocks have become solid from a melted liquid state. *Extrusive igneous rocks* are those that arrived on the surface of the earth as molten lava and cooled. *Intrusive igneous rocks* are formed from magma (molten rock) that forced itself through cracks into rock beds below the surface and solidified there.
- **Example:** granite, Basalt, gabbro

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So, this is a igneous rock. The igneous rocks actually this rock have become solid from a from a melted a liquid state and it can be extrusive and intrusive type. Extrusive into igneous rocks are those that arrived on the surface of the earth as molten lava and cooled. And intrusive rock and igneous rocks are formed from magma molten rock that forced itself through crack into rock beds below the surface and solidified there itself.

So, this is the two categories again in the igneous rock itself, and they are intrusive and extrusive. And under this there are few name I can mention, the granite is one of the igneous rocks, Basalt is another Gabbro is another there are quite a few also.

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Name	Grain Texture	Color	Composition
Granite	Coarse	Light Gray	Mainly quartz and orthoclase mixed with biotite, muscovite, hornblende, magnetite
Gabbro	Coarse	Dark	Mainly plagioclase and pyroxenes mixed with biotite and magnetite
Basalt	Fine	Dark	Mainly plagioclase and pyroxenes mixed with biotite and magnetite

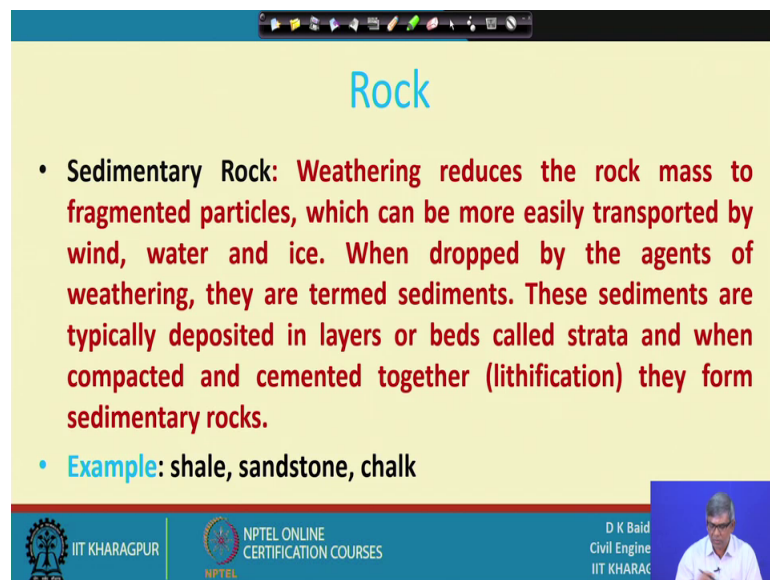
And igneous rocks example and characteristics I have given three names, I am trying to give some characteristic so that if you see the rock then you can also identify them whether this is igneous rock or whether it is sedimentary rock or whether it is metamorphic rock, again if it is igneous rock what type of igneous rock that also you can find. So, some basic characteristics are given here granite. So, granite if it is a generally grain structure will be very coarse, and color will be light grey and composition mainly quartz and orthoclase mixed with biotite, muscovite, hornblende and magnetite.

So, generally if we see the physically rock we generally see the texture and color, and also by chemical analysis and other thing you can do then other composition or crystal you can find out and based on that we can confirm what type of rock it is. And granite is a very strong rock, then next was next is annexed Gabbro. Gabbro again it is the grain

grain texture is coarse and color is dark, and mainly plagioclase and pyroxenes mixed with biotite and magnetite.

So, again Gabbro is not a very common rock we granite we use basalt we use there is third our rock is basalt, and basalt and Gabbro they are almost similar composition wise; you can see basalt is grain structure is fine and it the color is dark similar to Gabbro and composition also similar mainly plagioclase and pyroxenes mixed with biotite and magnetite only by texture we can differentiate between Gabbro and basalt. And granite and basalt these two rocks are heavenly used available and also use in various civil engineering activities.

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The slide is titled "Rock" in blue text. It contains two bullet points in red text. The first bullet point describes sedimentary rocks as fragmented particles formed from weathered rocks. The second bullet point provides examples: shale, sandstone, and chalk. The slide footer includes the IIT Khharagpur logo, NPTEL Online Certification Courses logo, and a small video inset of a speaker.

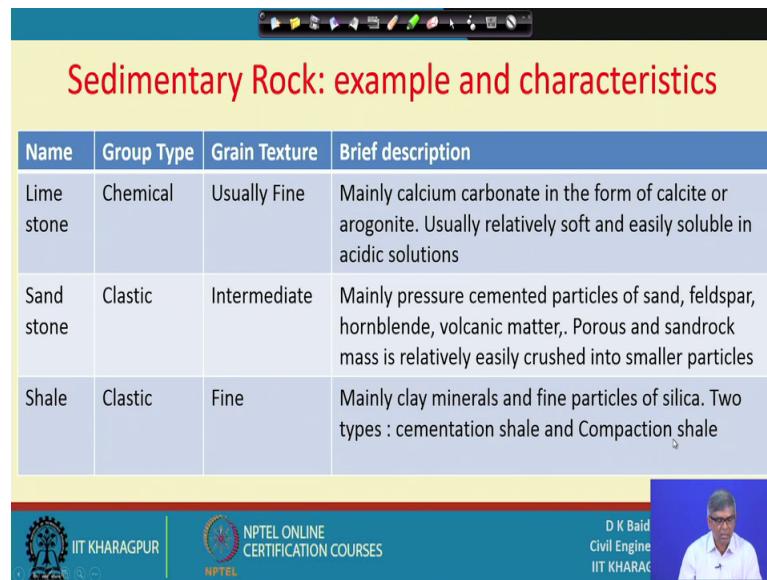
Rock

- **Sedimentary Rock: Weathering reduces the rock mass to fragmented particles, which can be more easily transported by wind, water and ice. When dropped by the agents of weathering, they are termed sediments. These sediments are typically deposited in layers or beds called strata and when compacted and cemented together (lithification) they form sedimentary rocks.**
- **Example: shale, sandstone, chalk**

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Then next is sedimentary rock. Weathering reduces the rock mass to fragment particle fragmented particles, which can be more easily transported by wind water and ice. When dropped by the agents of weathering they are termed sediments. And these sediments are typically deposited in layers or beds called strata, and when compacted and cemented together they form sedimentary rock and example under this category shale, sandstone and chalk.

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The slide features a title 'Sedimentary Rock: example and characteristics' in red text. Below the title is a table with four columns: Name, Group Type, Grain Texture, and Brief description. The table lists three types of sedimentary rocks: Limestone, Sandstone, and Shale. At the bottom of the slide, there are logos for IIT KHARAGPUR, NPTEL ONLINE CERTIFICATION COURSES, and a video feed of the presenter, D K Baid, Civil Engineer, IIT KHARAG.

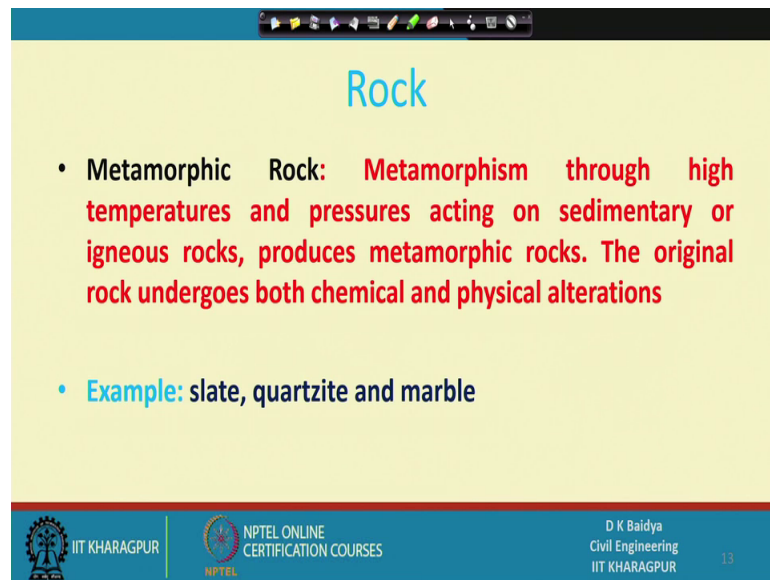
Name	Group Type	Grain Texture	Brief description
Lime stone	Chemical	Usually Fine	Mainly calcium carbonate in the form of calcite or aragonite. Usually relatively soft and easily soluble in acidic solutions
Sand stone	Clastic	Intermediate	Mainly pressure cemented particles of sand, feldspar, hornblende, volcanic matter,. Porous and sandrock mass is relatively easily crushed into smaller particles
Shale	Clastic	Fine	Mainly clay minerals and fine particles of silica. Two types : cementation shale and Compaction shale

And let us see their characteristics sedimentary rock example and characteristics you can see limestone is one of them, and it is generally group type is a chemical the weathering different agencies by different agency whether it can take place, that is actual chemical weathering happens to form limestone from sedimentary from igneous rock.

And grain structure is generally usually fine, and brief description mainly calcium carbonate present in the form of calcite or aragonite and usually relatively soft, and easily soluble in acidic solutions. So, this limestone can be identified by this by seeing this and sandstone it is plastic, plastic means it is a fragmented older rocks and the grain structure is intermediate. Mainly pressure cemented particles of sand this is the weathering process actually, pressure cemented particles of sand feldspar hornblende, volcanic matter by that those are actually the present in it and it is porous and centre of mass is relatively easily crushable into smaller particles.

And last one there are many, but which I have listed here shale which are well known that is shale. The shale again is a plastic; that means, is a older rock fragments together that is actually shale, this is texture is fine usually fine. And mainly clay minerals and fine particles of silica, and two types of cementation can happen cementation cell and compaction cell. So, these are by and large very briefly about the rock, and next we will try to see how again further weathering process this rock can transform into the soil.

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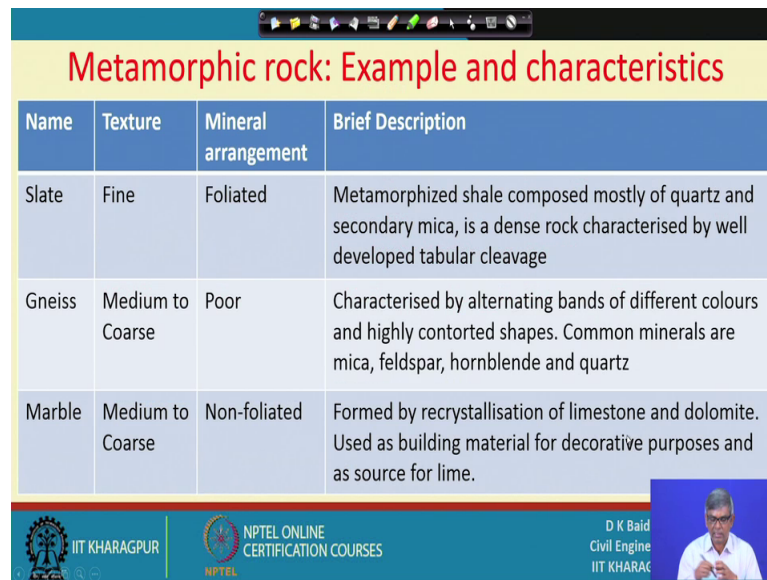
The slide is titled "Rock" in blue text. It contains two bullet points: the first defines metamorphic rock as a result of metamorphism through high temperatures and pressures acting on sedimentary or igneous rocks, leading to chemical and physical alterations; the second lists examples: slate, quartzite, and marble. The slide footer includes the IIT Khharagpur logo, NPTEL Online Certification Courses logo, the name D K Baidya, the subject Civil Engineering, and the page number 13.

- **Metamorphic Rock:** Metamorphism through high temperatures and pressures acting on sedimentary or igneous rocks, produces metamorphic rocks. The original rock undergoes both chemical and physical alterations
- **Example:** slate, quartzite and marble

Then next is metamorphic rock. Metamorphic rock actually it is requirement the metamorphism is required. So, metamorphism through high temperature and pressure acting on sedimentary or igneous rocks producers at metamorphic rocks, and the original rock undergoes both chemical and physical alteration.

So, this will from the original rock whatever was there, the it will be changed totally chemically and physically also and some example is slate, and quartzite, and marble there are many, but I have listed here they are well known and this three their characteristics let us see.

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Name	Texture	Mineral arrangement	Brief Description
Slate	Fine	Foliated	Metamorphized shale composed mostly of quartz and secondary mica, is a dense rock characterised by well developed tabular cleavage
Gneiss	Medium to Coarse	Poor	Characterised by alternating bands of different colours and highly contorted shapes. Common minerals are mica, feldspar, hornblende and quartz
Marble	Medium to Coarse	Non-foliated	Formed by recrystallisation of limestone and dolomite. Used as building material for decorative purposes and as source for lime.

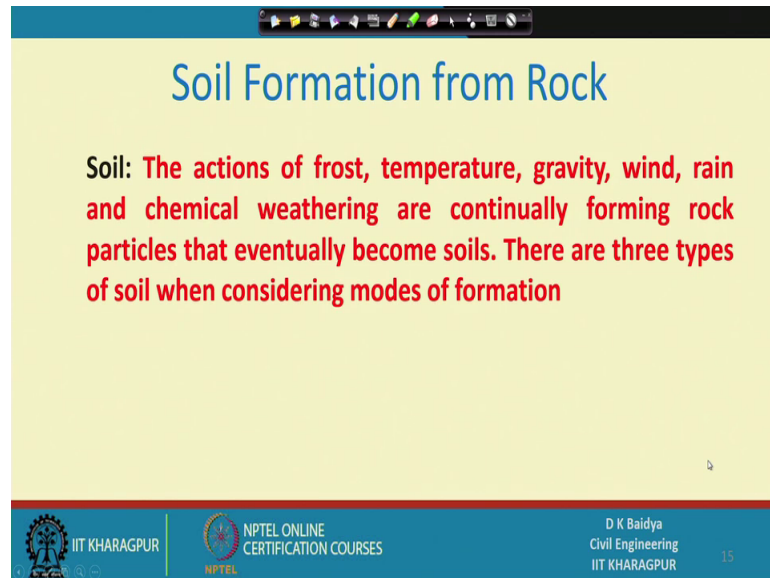
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Slate the structure is fine and mineral arrangement is foliated. And brief description is it is metamorphosed morpho morphized metamorphized shale composed mostly of quartz and secondary mica and is dense rock characterized by well developed a tabular cleavage. We can see those cleavage if you look at the shale cell structure; then is the structure is coarse medium to coarse and mineral arrangement is very poor and characterized by alternating bands of different colors, and highly contorted shapes.

Common minerals are mica present in it, mica, feldspar, hornblende and quartz. And marble its texture is medium to coarse and mineral arrangement non-foliated and formed by recrystallisation of limestone and dolomite, and used as building material for decorative purposes and as source of as source for lime. And you know that is a very essential that marble is a very good building material and it can take very good polish and that we use a for flooring purposes and many other decorative purposes.

So, these are very briefly how rock formed and how one rock to other rock form, and then different composition and their identification procedure briefly were discussed. Now we will enter into how again from rock again transform into soil by again several processes like weathering, chemical processes or some other agencies.

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The slide features a title 'Soil Formation from Rock' in blue text at the top. Below the title, a paragraph in red text states: 'Soil: The actions of frost, temperature, gravity, wind, rain and chemical weathering are continually forming rock particles that eventually become soils. There are three types of soil when considering modes of formation'. The slide footer includes the IIT Kharagpur logo, NPTEL Online Certification Courses logo, the name 'D K Baidya', the course 'Civil Engineering', 'IIT KHARAGPUR', and the slide number '15'.

And soil formation from rock, can I stop here.

Student: Sir, stop.

[FL].

Student: [FL].

So briefly I have described the rock formation and transforming one rock to another rock how by different physical and chemical processes is the transferred from one rock to other, and how I have given also some example of rocks from different categories and their characteristics. And next session I will try to describe how from this rock again by different processes, how the rock transform to soil; that I will discuss in the next session.

Thank you.