Fundamentals of Environmental Pollution and Control
Prof. Jayanta Bhattacharya
Department of Mining Engineering
Indian Institute of Technology, Kharagpur
Lecture No. # 24
Soil Erosion

So, we were dealing with this soil erosion you know and just now that we have introduced soil erosion due to the large scale displacement of soil from existing area to a new area or in any other place as in river, ponds, etc, okay.

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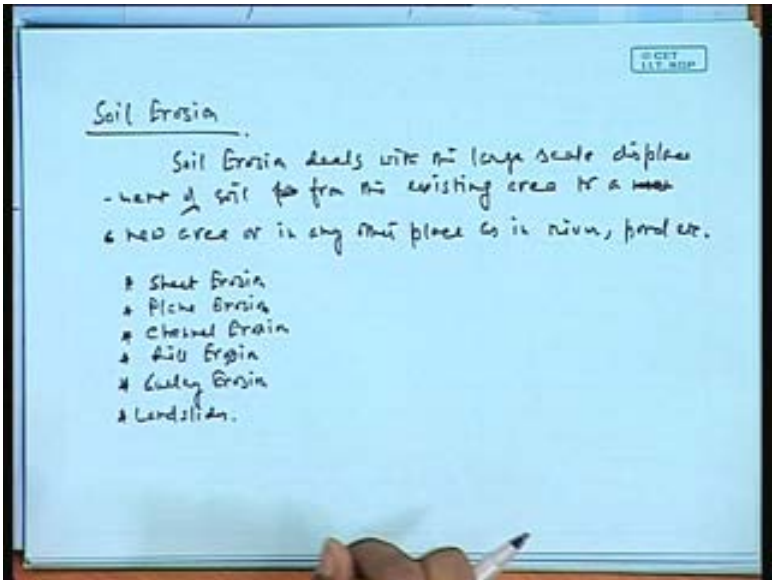

Now having to say that there are few important things that you know the different kinds of soil erosion that we discuss today is that you know one is called sheet, sheet erosion, sheet erosion also called you know is also known as it's okay, there is another called plane erosion, plane erosion. The third one is you know you say now then we can say this channel erosion, channel erosion then rill erosion and finally would also take a little bit on this is also a part of erosion only, this is landslides, landslides, okay. So, having to say this, this is the channel erosion, plane erosion, the sheet erosion, plane erosion, channel erosion, rill erosion, galley and landslides. Let me further explain on this. What happens here is if you just observe these things you know, you know somewhat more detail in any kind of soil, in any kind of soil it is particularly in a say deforested, deforested soil or say mostly say deforested soil or disturbed soil, disturbed soil. The erosion that is quite common is sheet erosion. Also the sheet erosion is a usual form of erosion; it is a very typical very common type of erosion as usual and common form of erosion.

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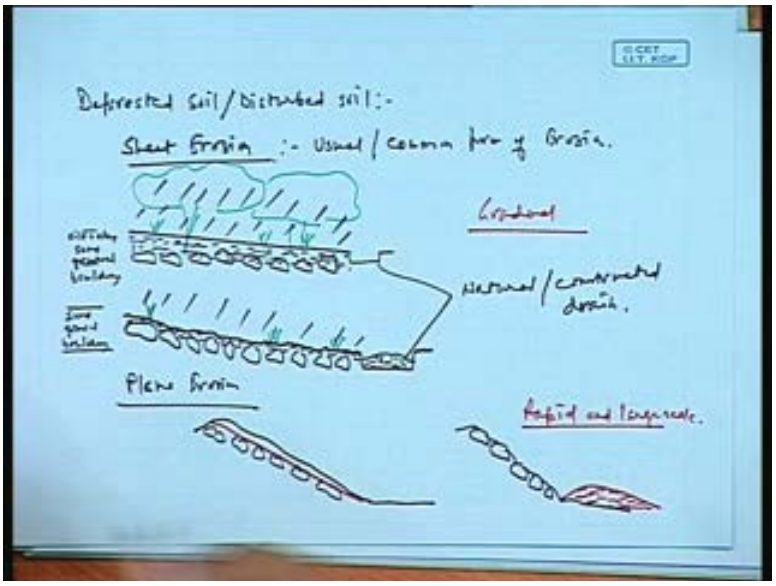

It happens like this. If you just you know just try to think of a slightly inclined soil surface or you know the soil surface having a drain, having a drain like this and if you just observe this soil surface, you have there is no vegetation on this, no, generally no vegetation or even if there are very vegetation, very little vegetation at areas like this little vegetation, little vegetation in this area you can see this kind of soil having, having you know if you see the structure here you see just observe that you know the top one is, the top one is we have finer particles you know in the finer particles generally this is you know this.

So, we have a finer say you know the top one is if you just for a simple description, if you see this, this one is this is a, is a silt and clay, sand, gravel, gravel and then you find boulders, okay. This is how the soil is, this is how the soil is just freshly exposed soil, this soil would not, is not you know is does not get a support from any of the plants or anything that would hold them together. So, generally after a rainfall, generally you say after a rainfall if you just see this after a rainfall, after a rainfall say something like this where the rainfall, large rainfall takes place, large rainfall takes place. We observe across the plane, across the plane, across the plane there would be across the plane this would be looking like after sometime, this would be, this soil after sometime would be looking like this, say I am sorry this one is after sometime would be looking like this okay.

Here you would observe that you know the surface has eroded and a large part of say this, this larger particles, mostly larger particles have been exposed here. You will, you will find some of, you will find some of this particles still remaining here. So, what usually used to be a structure which is, which are, which had a texture if you can see now the texture has gone change, we will find some sand, little sand, gravel and boulders. So, this is what has an, this particle, all this particle has mostly moved in this area. So, here all the water that is the water that begins to trickle, that water that begins to trickle has moved from this area, has moved from this area to this the, to a particular say you know naturally, natural you know natural drain or you know constructed drain or any other surface, this is you know natural or natural or constructed,

constructed drain, natural or constructed drain it has moved. This is what is called as, this is one is known as sheet erosion, this would be across the area, the total area would be affected. This is called the sheet erosion, this is called the sheet erosion. So, you know ideally what is happening is all the fine particles in the soil, all the fine particles in the soil with the force of the rain water, with the force of the rain water would have wash away from the surface and move towards, move towards a natural drain or a constructed drain, okay. This is what is sheet erosion which is pretty common, I mean in any kind of soil when the soil is without any, when the soil is without any support, without any support, the soil is without any support we can see this kind of, this kind of erosion taking place, okay.

Now, this is what is the, is the sheet erosion. This is the first form of erosion which is quite common you know in most kind of soil, if the soil is a natural process, the soil would have gone would, go undertake some erosion. If it is a, if there is a, if there is a plant canopy, if there is a plant canopy is like you know in such cases like even you can see this you know is a large plants are there, large plants which are there already supporting this you know there is a large plant canopy is there on some of the soil, then also there would be some erosion taking place but this is a very nominal erosion say, about say a very insignificant amount may be of the total soil volume it would be about 2 to 3 %. That is a natural process that takes place but here again if this one continues, if this one is continuing we generally in also in some cases you know if it is, if it is a relatively if it is this is what is sheet erosion. In a plane erosion what happens is in a plane erosion generally, this particular if you just observe this if you observe a generally at higher, higher stiffness or higher gradient, at higher gradient if the same thing is taking place in the higher gradient you would observe that this particularly is this a larger body, a larger you know this is where you can see this, these larger particles are being observed like this whereas this total is the total surface, the total surface has, total surface has moved into this area. This is called a plane erosion where this is a, is a already a large volume in the plane, in the planner form from a plane would generally slide down, generally would slide down. So, this is what is you say almost similar, almost similar to sheet erosion.

The plane erosion is only a in the sense that you know is a massive displacement, rapid or massive displacement of soil from the soil surface whether the sheet erosion is gradual, it is taking is a gradual erosion, this is say rapid, rapid and you know rapid and a large scale rapid and large scale. So, you know this is what is plane erosion that is usually takes place in the soil, okay. Having to, having to drop from this, having to go from this you know you would found this channel erosion, the channel erosion is like this.

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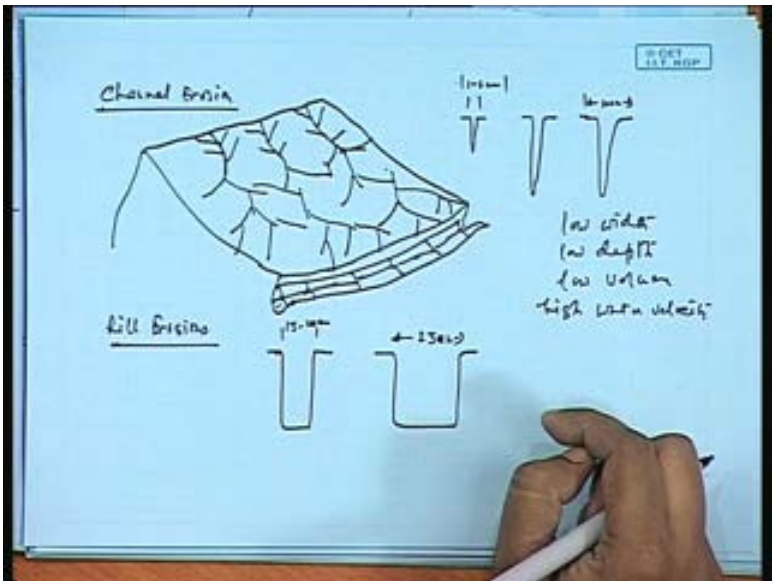

The next form you know is this is a channel erosion, channel erosion. The channel erosion what we observe you know if we just observe it as a plane like this, if you just observe a surface of soil like this, if you observe a surface of soil like this, this one is you know this one is say is this is what is the drain say you know this is where is a natural drain say consider this, okay. So, you can see think of it's a natural drain going out like this, all right. So, here you can see is a natural drain which is going out like this. This one here as soon as the first rainfall takes place, as soon as the first rainfall takes place what happens is in a generally in a surface like this completely denoted surface, this is the deforested area remember this, this is also deforested area and also you know in agriculture fields usually takes place, this is how it take place first. This is where this is depending on the soil characteristics, this is how, this is the channel should be begin to form, the channel should be begin to form depending on the slope and depending on say the depending of the water shade say you know this is how the channels, this is how the channels would form, the channel would begin to form like this, channels would begin to form like this, okay.

Now, this would begin to expand, this would begin to expand over, over time this would begin to expand. This would again take a turn again move like this, again two channels would combine together somewhere this is where… So, you can see this they would begin to form, this is what is called channel erosion through which, what is, what would happen is a channel the small channels like this would form say this the start of the channel would be like this, small one then the channels would begin to widen, this channels would be begin to widen. So, you know here it is like this, it would begin to widen. So, these are the channels, this channels, this channels would be mostly start with say 1 to 2 centimeter but you know at the end it can be up to 10 centimeter here okay. This is 1 to 2 centimeter; this is where it would start. So, this is what is the channel okay this channels you know this channels as I have said this would combine, this would combine would form you know finally if is finally come here and this should be all deposited, the all this, this the you can observe there the new deposition of soil, new deposition of soil taking place across, across this, across the natural drain.

So, here you would observe that you know this, the new deposition has taken place, this new deposition has taken place. So, this is what is the new deposition from all the soil surfaces, from the soil surfaces, all this are taking place here. Now here one important thing is this channel, this channel is this channel then you know channel then we from the channel we find the rill, rills or the rill erosion or the rills, we generally call them rills. So, here this channel should begin to after 10 centimeter say this channel would begin to widen also at the bottom, this would also begin to widen at the bottom and also at the surface. So, these are, these are known as the rills, these are the known as the rills. So, these rills should be say about 15 to 20 centimeter here and then it can be up to say about say 0.25, 25 centimeter to 30 centimeter like this. This is what is a rill, this finally from this the rills, extended rills when there is extensive rill formation this is what is the, this affect would be almost the same, effect would be same only the quantity of material that would be eroded would be more and more, okay.

This is a typical type of erosion that takes place you know particularly in the agricultural field, in the denuded forest or you know any other forest area, river banks, if you just observe the river banks you will find this kind of erosion taking place, this is called a rill erosion. If the rill erosion is, the rill erosion is this channels become deeper, so you know as this can be, you can write down here the channel erosion is the first form of, the channel erosion is the first form of erosion that begins in a, that begins in a soil plane, that begins in a soil plane. Initially of low width and low depth, initially of low width and low depth, of low depth their depth begin to increase, their depth begin to increase and can reach about, and can reach about, and can reach about 30 to 40 centimeters, can reach about 30 to 40 centimeters, 30 to 40 centimeters.

Since, since, since they are of low volume, they are of low volume they allow water to flow, they allow water to flow in high velocity, they allow water to flow, the rain water to flow in high velocity, they allow the rain water to flow in high velocity thereby increasing erosion, thereby increasing erosion, thereby increasing erosion, thereby increasing erosion at the bottom, thereby increasing erosion at the bottom as well as in the top, as well as in the top, when only, when only the rills begin to form, when only the rills begin to form, begins to form, begins to form, rill erosions begin to form. All this, all the above erosion, all the above erosion decreases the amount of soil particles and the amount of soil particles particularly, particularly silt and clay or the dissolvable fraction or the dissolvable fraction of soil nutrients or the dissolvable fraction of soil nutrients that are important for plant growth, that are important for plant growth, that are important for plant growth, that are important for plant growth. It would take quite a lot of engineering task, to take a quite a lot of engineering task to replenish the soil, to replenish the soil, to replenish the soil back to its original quality, back to its original quality, back to its original quality.

Galley erosion, this is galley erosion, in the galley in the, in the galley erosion, in the galley erosion rills become, rills began, begin to, rills begin to further widen, begin to further widen, begins to further widen, begin to further widen and their network and their network begins to intensify and their network begins to intensify, their network begins to intensify, begins to intensify, begins to intensify, begins to intensify, begins to intensify. This problem becomes particularly evident, this situation becomes particularly evident, this situation becomes particularly evident in high rainfall areas, high rainfall areas, rainfall areas having, having deforested lands and burning, and burning kind of cultivation, burning kind of, burning kind of

cultivation, burning kind of cultivation. Let me explain you little bit of this burning kind of cultivation particularly if you go to north east areas, this would be very common to you, common, common features. What happens there is, this, the they what they do the tribals in the mostly the local what they do is this is the most unscientific form of, unscientific form of cultivation.

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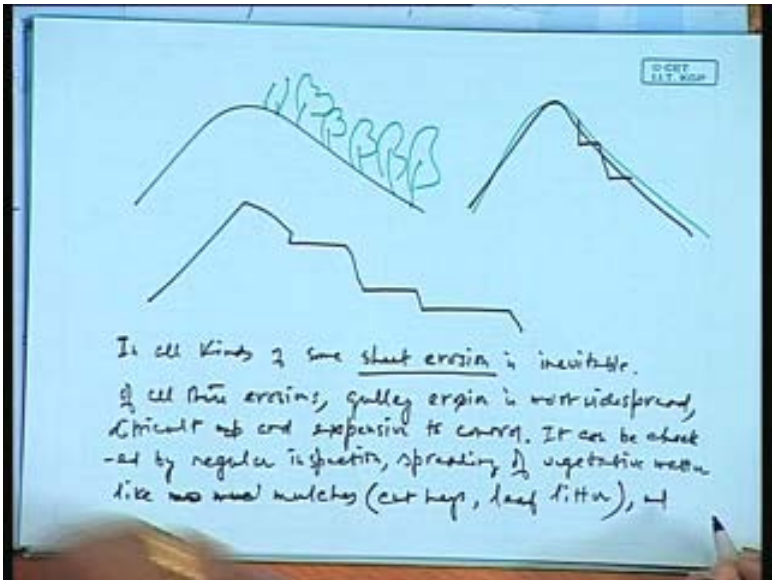

What happens is this is the plant areas you know they have mostly in this the particularly in the, on the mountain zones like what they do is they burn them, okay. So, the burn them means you know what happens burning them and then leaving it for to, that leaving it to for rain. The first season of raining what happens is first season of rain, the soils becomes enriched with nitrogen because the leaves all the plants that have burnt it you know this would be the soil would be enriched with nitrogen. So, they do this say they do here they do say a cultivation on that area say is a cultivation like you know this you would find mostly the step kind of cultivation you know something like this, something where you would find cultivation like this you know cultivation this is called a zoom kind of cultivation in this areas.

Now, what happens is eventually suddenly the plant, the soil so nutritional capabilities would go down, the soil would not be any more enriched. So, after 2 or 3 cultivation or say utmost 3 or 4 cultivation, the soil again becomes infertile. So, they move from that place to another place, this is the very typical kind of cultivation practice that they do. So, as a result of that this particular soil becomes completely denuded of large plants as also at the same time the soil becomes weak. So, in such areas this kind of soil erosion, the galley erosion and all these things are quite common, quite common and you know it leaves you know a large area of soil being completely denuded, completely, completely devastated with erosion. See, of all these erosion types that we have discussed from this you know, generally what happen, what happens mostly is says in all, in all kinds of soil, in all kinds of soil, in all kinds of soil, soil some sheet erosion, some sheet erosion is inevitable, you cannot help sheet erosion would take place, the sheet erosion would take place but this sheet erosion would take place.

Galley erosion, however this is galley, galley erosion of this, of all these erosions, galley erosion is perhaps galley erosion is, galley erosion is most wide spread, most wide spread, most wide spread, difficult and expensive, expensive to control, okay, that is a most expensive to control, now most expensive to control. It can be checked by regular inspection, regular inspection spreading of, spreading of vegetative matter like, vegetative matter like mulches that the mulches are mostly the cut hey, cut hays, hays that you know after this, after the paddy that is you know the hey that remains. Those what they do is generally cut them into pieces and spread over the soil. So, this is one way of spreading, reducing say spreading cut hays, leaf litter and by which very inspection and other mechanical means and other and other mechanical means, other mechanical means, other mechanical means.

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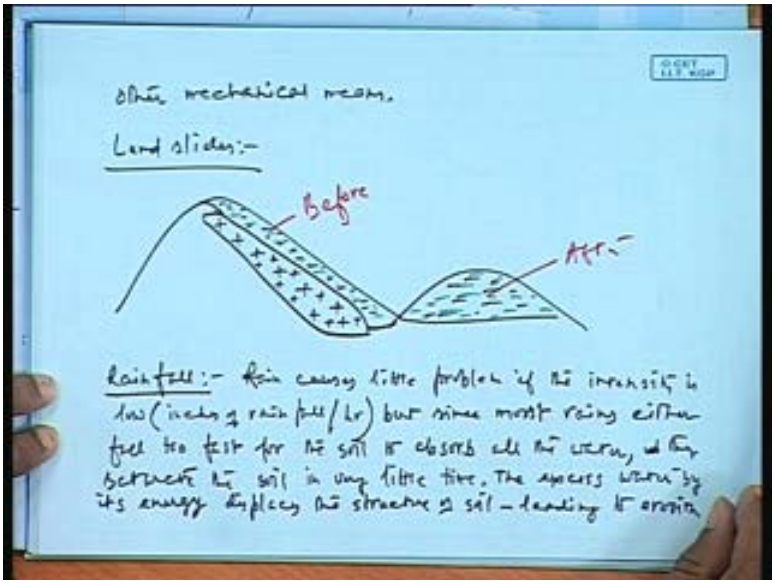

So, this is, this is can be only be restricted like this. Having to say also you know is mostly another important aspect is the landslides. The landslides you know somewhat different you know in the sense that mostly, mostly the landslides usually is also related to denudation of forest, denudation of cutting of trees essentially is also related to the cutting of trees but there is some characteristic difference here. We just say you know suppose there is a, there is a, there is a, there is a say a particular rocky surface here you have soil, you have soil, here you have soil if you make a section, if you make a section across say you know across any slope because section across any slope and this is what is the rock surface say you know any granite or sand stone, the typical types of or any kind of rock surfaces that we generally observe here.

What happens is, what happens is this essentially does not form in the form of a sheet erosion or a plane erosion. What happens is you know as you can see, as you can see this you know the friction becomes less between the two surfaces, between the internal the friction becomes less between the two surfaces. This slope, this particular, this particular layer of soil begins to move, begins to move if you just observe this, this particularly finally you know this would be begin to almost completely begin to move like this.

So, the whole soil is, the whole soil would be forming, so this one was, this one is, this one was this before, this was before, this one is after whereas this you know here after this has taking place this particularly what we observe is this total material, this total materials say from here this total material has moved, the total material has moved. So, this total material has actually moved from, the total material here would basically this total material here would essentially move into this area. So by, thereby exposing this complete area this is what is a typical landslide, this is what is typical landslide. The reasoning is somewhat different in the sense that this is a particularly in the mountainous region, mountainous region when there is a large rock surfaces just below the sand and soil surfaces that the coefficient of friction reduces due to, due to heavy rain fall and this that allows the soil surface to move from the top you know enormous that you know it begins to move enormous you know and it is this is how it would look like at the end.

So, this is what is the landslide. The landslide is you can just write down a line, landslide is, is a, is a rapid displacement of large mass of rock and soil, large mass of rock and soil, large mass of rock and soil in a, in a moderately in, in moderately steep, a moderately steep slope, moderately steep slope of more than 30 degrees, of more than 30 degrees. Landslides usually take place because of lowered, because of lowered, lowered frictional resistance between soil and rock surfaces during rainy season, during rainy season, during rainy season, during rainy season, during rainy season, during rainy season, during rainy season, during rainy season. So, connected with this erosion is connected with this erosion is another parameter that would be these are the features of the erosion that we have discussed, there is another important parameter that also leads to a large scale displacement of soil, this is known as rainfall.

Rain causes, rain causes, rain causes little problem if the intense, if the intensity is low that is intensity is low that is you know would be say inches of, inches of per hour, inches of per if the, if little problem if the intensity is low inches of rainfall per hour but since most rains either fall too fast for the soil to absorb all water, since most of the rains either fall too fast for the soil to absorb. They saturate the soil, saturate the soil in very little time, in very little time rain causes little problem if the intensity is low inches of rain fall per hour that is how it generally discuss intensity but since most rains either fall too fast for the soil to absorb all the water, this saturate the soil in very little time, a very little time. The excess water by its energy displaces the structure of the soil, displaces the structure of the soil leading to erosion, leading to erosion.

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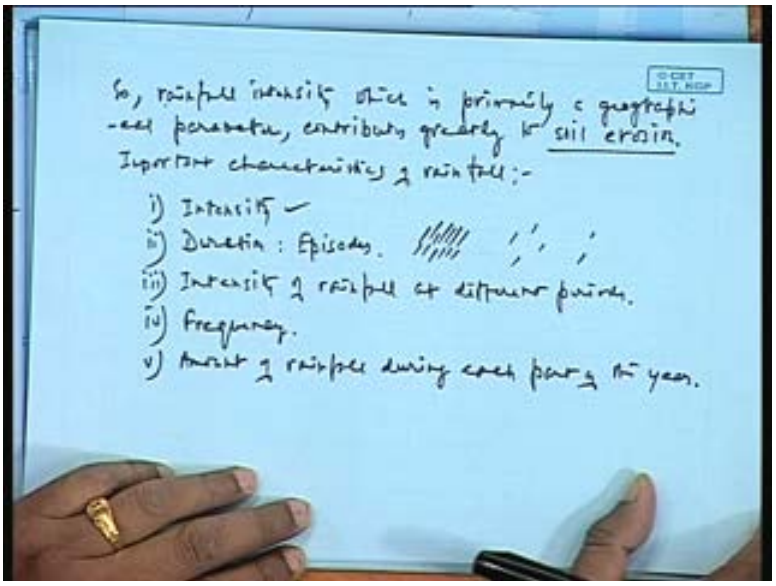

So, rainfall intensity which is primarily, primarily this so rainfall intensity which is primarily a geographical, geographical parameter, rainfalls intensity which is primarily a geographical parameter contributes greatly to soil erosion. So, you can see this other things remaining same, other things being same. The variation in the rainfall would lead to higher erosion if of the same kind of soil are existent in two places like you know if the same kind of soil is present in say Rajasthan area or say even in Andhra Pradesh or say or in say the particularly very high fall rain, rainfall area like in Assam or Tripura or places like that depending on the geographical situation of that particular place the erosion would increase or decrease.

So, essentially erosion would be more in areas like in the north east like in the Assam, Tripura area than that of in the regions like Hyderabad or regions like Rajasthan like this, regions in Andhra Pradesh or like that. So, this is the, this is erosion you say the very important parameter we would come to discuss about this, this the rainfall the important characteristics of rainfall, important characteristics are, important characteristics of rainfall, important characteristics of rainfall are say its intensity, intensity. Second is duration, duration, duration or it can be say intensity, duration or also is called episodes, episodes, intensity at different periods, at different periods, frequency, amount, amount of rainfall or rainfall during each part of the area, each part of the year sorry each part of the year. So, to important characteristics intensity that I have said the duration, the duration is like this you know this is episodes what we discuss about this episode like you know say if there is low rainfall say this is, this is a very highly intensive rainfall say you know just to pictorially if we explain this.

The very low intensity rainfall may be you know something like this okay even lower may be something like this. So, here you know in a rainfall, in a rainfall these are you know at different type the rainfall would be like this the high intensity, low intensity, high intensity, low intensity, higher intensity, very critical intensity these are called the episodes, these are called the episodes. So, the durations or the episodes are related to that very high fall for during the time typical time, the time that is generally existent in that area, intensity of rainfall at different periods, frequency,

amount of rainfall during each part of the year. These are all the most important I will come back to this again you know there are many things that we generally deal with this.

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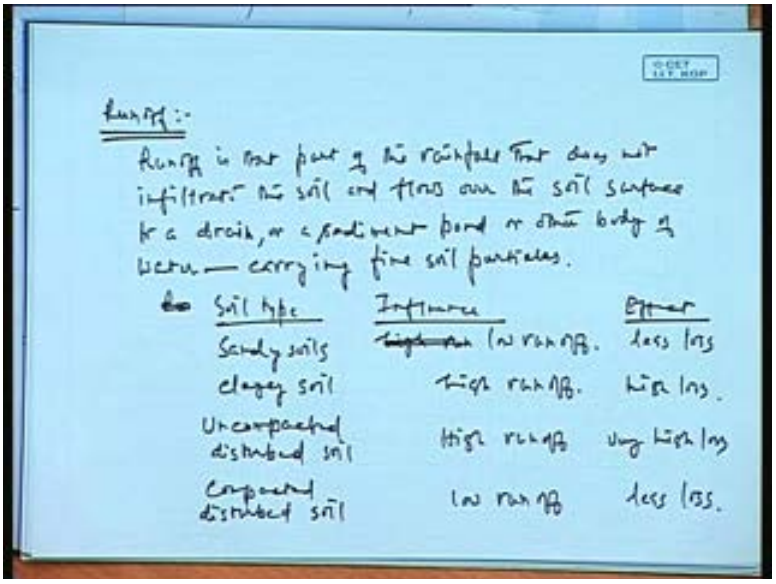

Another important thing that you know is just briefly I will discuss is Runoff, runoff, runoff is that part of, that part of the rainfall that does not, that does not infiltrate, infiltrate the soil and flows, flows of the soil surface to a drain or a sediment pond. I will discuss this sediment pond sediment, sediment pond, sediment pond, sediment pond or other body of water, other body of water. So, this yes, this, with this you know this has a great important in the sense like this say influence soil type and influence. If we just see the soil type, this sandy soils high infiltration so low runoff, clay soils, clay soil, high runoff uncompacted, uncompacted disturbed soil, compacted disturbed soil. This is, this is low runoff influence effect less loss of soil particles, high loss, less or low loss.

So, this is one is, this is the effect of runoff. The runoff is, the runoff is the part of the rainfall that does not infiltrate the soil and flows over the soil surface to a drain carrying, carrying fine soil particles. So, this is, this is the effect of runoff. So, mostly you know this generally explains about how the soil can be disturbed, how the soil can be disturbed and what are the effects, how this soil mostly get disturbed due to different kinds of activities. So, you know is though I have not specifically discussed about the soil being disturbed by engineering activities I have said that you know if the soil is disturbed by all means what are the likely effects that can be seen on the soil. So, this should you know this should be sufficient to for you to understand how this soil erosion takes places and what are the things you should take care of. Okay in the next class we will begin the next topic again, okay fine.

Preview of next lecture:

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So, today we'll begin this you know the topic mechanical soil erosion control. We have discussed about soil erosion essentially we have discussed about you know how soil generally becomes eroded and the typical mechanism of soil erosion has already been explained and we have also explained that you know how this you know land slide usually take place. So, generally the part of the typical physical mechanism that takes place in such situations we have already discussed. We would now today discuss about how this thing, this can be controlled, the soil erosion can be controlled. I explain you know one important thing about erosion is mostly about the, about the rainfall is about the rainfall becoming rainfall being very important.

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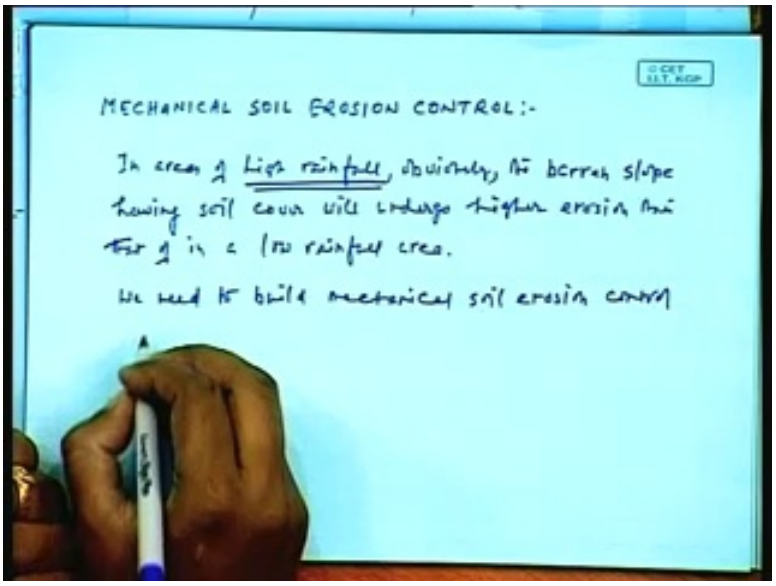

So, this is in areas, areas of high rainfall, rainfall obviously, obviously, obviously in areas of high rainfall obviously the barren slope, barren slope having soil cover will undergo, undergo higher erosion, will undergo higher erosion than that of in a high rainfall, low rainfall area okay. So, with these things you know so you can high rainfall area mostly in high rainfall area we need to, we need to build, we need to build, we need to build, we need to build mechanical soil erosion control. So, these things you know water harvesting is becoming extremely popular nowadays in India across the, across small streams, small ponds you know this water harvesting is being applied and in many situation it has given dramatic results you know, you know particularly in many villages it has helped make, helped improve the life of the villages by lifts and bounds I mean in many cases a by because of water harvesting a village may be able to generate 2 or 3 crops in a year in comparison to one crop that it used to do in a year. So, as a result of that number of economic benefits have also accrued and not only that it has also served the use by means of drinking water, say the drinking water is also being more available with the effect of such kind of structures.

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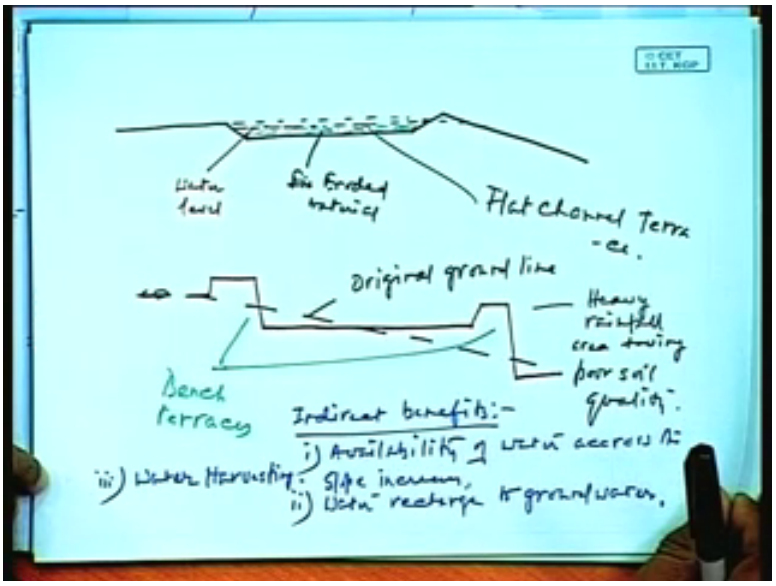

So, here we see that you know this, this is the, these are the terraces that the flat channel terraces that we know we make say bench terraces. These are the different types of terraces and their uses okay. I mean there are some design aspects, the design aspects are very simple I mean it's not much of a thing here is to say is observe is that you know depending as I have said. So, depending on the structure of the slope, depending on the availability of the slope you know you can and the rainfall pattern you can try to think of how you are going to what kind of terraces you are going to have you should also have an understanding, how much rainfall you expect, what should be the catchment area by which the water can be actually caught into so that the water should not spill I mean your design should be such that the water does not spill out from the terraces. So, these are the some of the things that you know the design aspects that are generally simple in nature but you know are also very, very useful okay.

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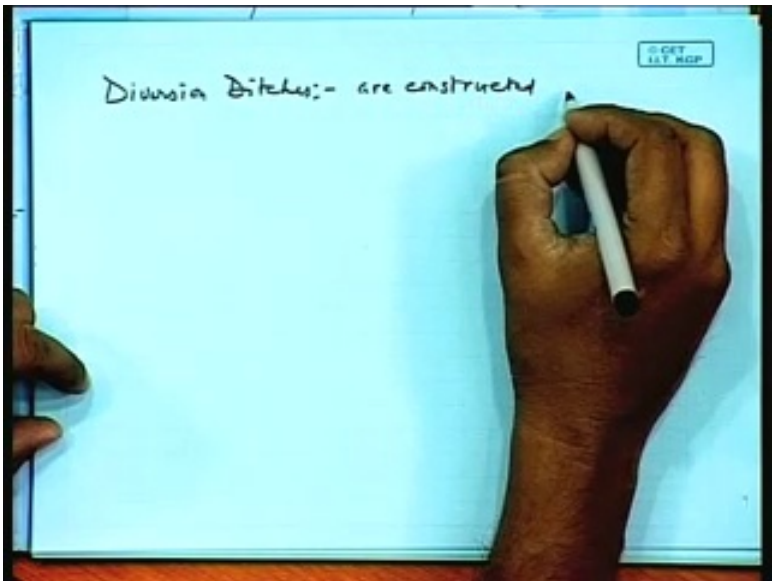

Now, having to say this, having to say this you know with these things in mind the next is the diversion ditches. After what is you know is mostly you know in cases of diversion ditches the examples of this generally either independent or you know connected with the terrace the diversion ditches are constructed diversion ditches are constructed, constructed.