Fundamentals of Environmental Pollution and Control
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Lecture No. # 25
Mechanical Soil Erosion Control

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 landslides 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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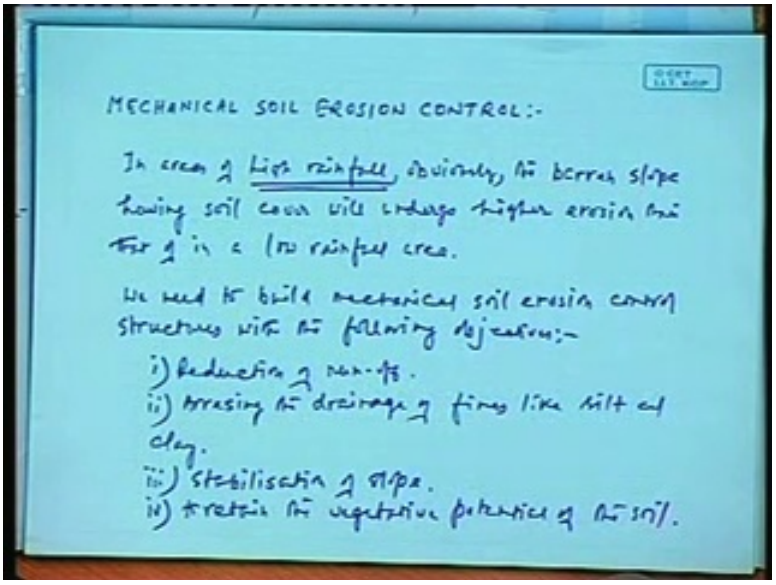

So, this is in areas, areas of high rainfall, rainfall obviously, obviously, obviously in areas of high rainfall obviously the barren slope, barren slope having soil cover will undergo, undergo higher erosion, will undergo higher erosion than that of in a high rainfall, low rainfall area okay. So, with 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 structures, we need to build mechanical soil erosion control structures particularly in high rainfall area, high rainfall area with a purpose, with the following objectives reduction of runoff obviously then arresting of fines like silt and clay, arresting the drainage of fines like silt and clay, reduction of runoff that I have already said, stabilization of slope, stabilization of slope and also the finally to retain the vegetative potential of the soil, to retain the vegetative potential of the soil right. So, this is you can see this is, these are the objectives of say mechanical soil erosion control.

Now, we'll begin the discussion about you know how this the soil erosion control the structures that we generally drew. So, the mechanical soil erosion control let us discuss about say this you know the one very important thing is the terraces.

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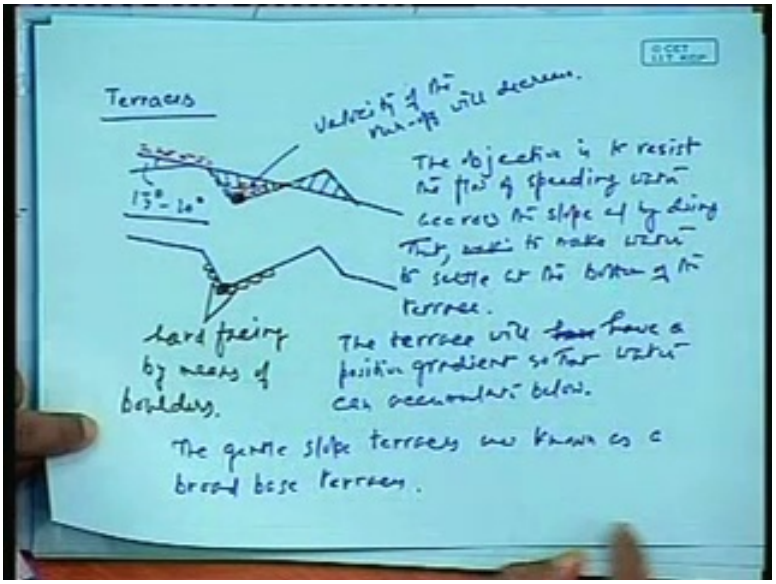

This mechanical soil control measures and the first one the mechanical soil erosion control measures, the first one that we the structure the terraces, terraces t e double r a c e s, terraces, this these are, these are the structures you know terraces of the structures that would be, we would require to construct say you know particularly, particularly in a, in a relatively flat slope, relatively flat slopes like this you know here you this is the slope area, this is the slope, a construction of this, construction of the terrace is like this. Say, this is what the area that would be excavated that is the area that would be excavated. This is the area excavated and this area, this is, this would be dumped here or stabilized here like this stabilized here like this. So, here this area as you can see this area would be excavated, this area would be excavated and would be dumped here.

So, here this would be the dumped area and as a result of which you can see now as a result of which you can see now that we have made a terrace, we have made a terrace which looks like this, we have made a terrace which would look like this. So, what is happening here is, what is happening here is say the most important thing about all this areas is that the rain water, rain water say the rain water instead of being running through the slope, instead of being able to running through the slope would finally, would finally accumulate here. So, this as a result of that the velocity of the runoff, velocity of the runoff will decrease, velocity of the runoff will decrease and this, this as it would be decreased so the, so the erosion over the complete surface would be reduced.

So, similarly so you know here what is important here is, so as this what we are trying to resist is at with the objective, the objective is to resist, is to resist the flow of speeding water across the slope and by doing that, by doing that, by doing that, by doing that to make water to settle at

bottom of the terrace. The terrace, the terrace will have a, have a positive gradient, positive gradient so that water can below, water can accumulate below, water can accumulate below. Sometime, sometime you know is sometime it is important sometime, sometime in cases of like this in cases that in cases of this terraces in terraces like this, in terraces like this as the terrace now here looks like this, as the terrace looks like this, as now the terraces nearly looks like this there are, there may be a requirement of some hard facing of the terrace say hard facing of the terrace instead of fine particles being here, we would try to put in some boulders and compact this area, compact this area so that the impact of velocity, impact of velocity on the terrace becomes less and that can substantially reduce erosion, substantially can reduce hard facing, hard facing by means of boulders, by means of boulders.

So, this gives you, this, this is one kind of terrace this is, this is called the, when the slope is, when the slope is gentle, when the slope is gentle see the slope is about say here if you can see this, this slope is being about say 15 to 15 degree to 20 degree we generally call these terraces as broad base terrace. The gentle slope terraces are known as, known as broad base terrace. So, here how do they look? This is just a cross section, this is just a cross section if you just take a you know a front view, a front view of a terrace, if you just take a front view of a terrace you know here it would be quite looking like this say you know in case of a slope, in case of a slope like this in case of a slope like this, in case of a slope like this you have a, you just see your facing this slope, your just facing this slope say here you see this is where the green one shows the water line of the terrace. This is, these are the called the water lines, water lines of the terrace.

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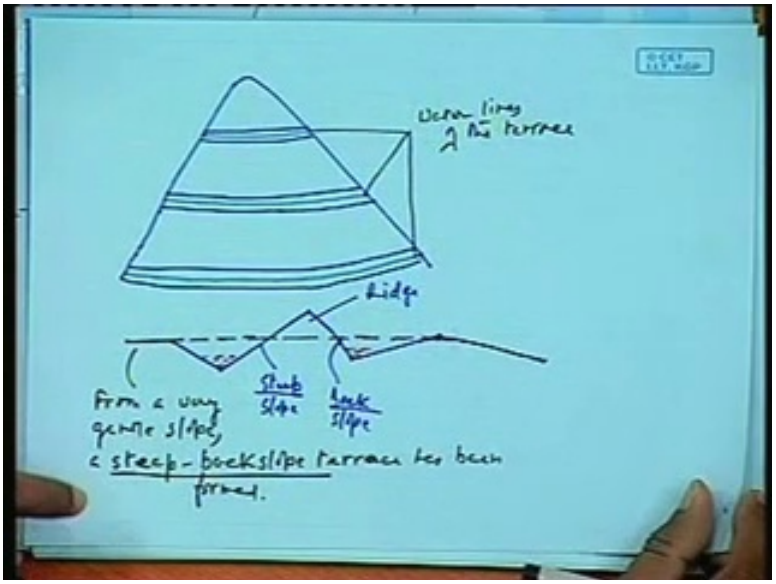

You see in the last picture that we have shown the water line of the terrace is here, this is where that the water line, water line of the terrace. So, you know through which the water would begin to pass. So, as you can see this is would be encircling as you see in a mountain road or in a road near a slope, as you can see as the slopes keep rounding off, so similarly all these slopes would be combining together and this, the water which would be, which would be, which is supposed to

come out through the slope would be diverted to the terraces and through the terraces it would come down at the bottom, okay.

This is now this is, this is a, this is a particular kind of terrace, this is a broad based terrace that I have discussed. There are few other kinds of terraces like say this kind of terraces are also common where you can see this, this is, this is a terrace also this is what you can see here is we have, what we have made of a gently, very gentle plain slope from a very gentle slope, from a very gentle slope, a steep, steep back slope, slope, terrace, terrace has been formed, has been formed. So, you can see their back slope terrace so it's a constructed ridge, this is called a ridge. This is what to say this is the, this is what the material would be mostly say this is, this is called steep, this is steep, steep slope, this is the back slope.

So, this together steep back slope terrace that is what the name is generally derived. So, the ridge is constructed so you know here it just tries to show here that the initial from the initial level, from the initial level as can be seen here from the initial level, from the initial level drawn in black, you can see this is how the ridge has been formed. So, the ridge has been formed and this we have found out is steep back slope, steep back slope terrace has been formed. There are few more types of terraces you know we'll just also see them. This is a steep back slope terrace that is generally made out of a, made out of a, there's a flat channel terrace, this is a flat channel terrace, this is a flat channel terrace you can see this.

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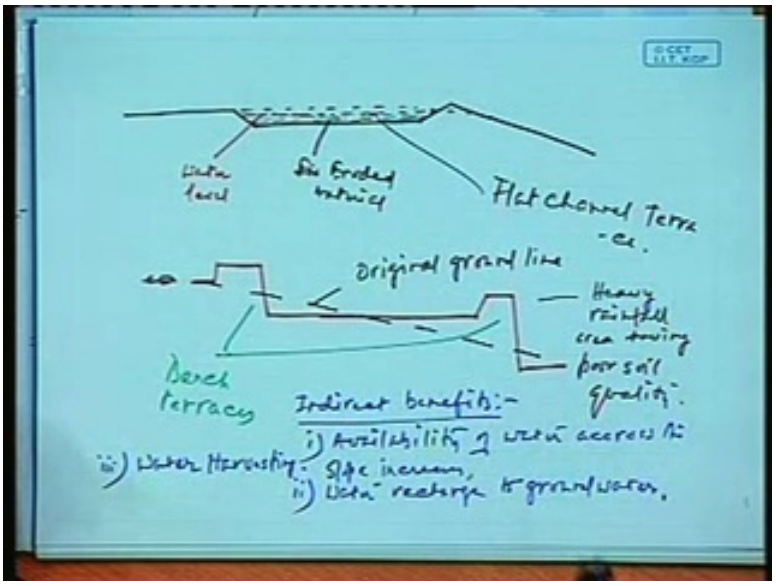

From this we have constructed we have made the fine sediments, fine sediments get collected over here and the water esentially remain on top of this. Water is the red one showing, the red one showing the water level whereas this one, this one showing the fine eroded material, eroded material and this is steam, this is called a flat channel terrace, this is called a flat channel terrace, flat channel terrace, flat channel terrace. There is another type of terrace you know which is, which is quite common as well which is known as say made out of say you know if there is a

slope like this depending on, depending on the rainfall, depending on the rainfall as well as to see what we have made out of a gentle slope.

See this is a, this is the original ground line, original ground line across the slope increases, availability of water across the slope increases. Another very important thing today this is another use is for water recharge to ground, ground water, water recharge to ground water say now these are, these as you know, you know mostly none cases you know something like water recharge to and the third one if you just point it out almost similar though you know you might sometime hear this term, this is known as water harvesting. Availability of water across the slope increases, so you know across the slope increases means the water that was generally flowing down, flowing down the slope is being arrested at different places.

So, suppose that say you know if the slope of say 400 feet or say 500 feet in such cases at say, at say 300 feet also you have a source of water because through the diversion ditches that the water you are collecting, you can collect in a pond or you can collect in a well or you can collect in any other tanker things like that. So, the water availability across the, across the slope increases, water recharge to ground water improves because you know it's very important nowadays that the ground water regimes are recharged. India is facing serious groundwater problem because of the low recharges. The recharges is you know its most of the groundwater sources are being pumped out daily in and out but they are not being recharged, completely recharged by rain water unless that is done the stock reduces. This kind of techniques, this kind of methods can help improve the water recharge to ground water and also water harvesting, water harvesting.

Say, you know particularly important is that the water that is available in the rainy season if we can store them, we can store them at appropriate places that water can be useful during the other times when there is no rain. 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 in particularly in many villages it has helped made, helped improve the life of the villages by leaps 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 in with the effect of such kind of structures.

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 it's 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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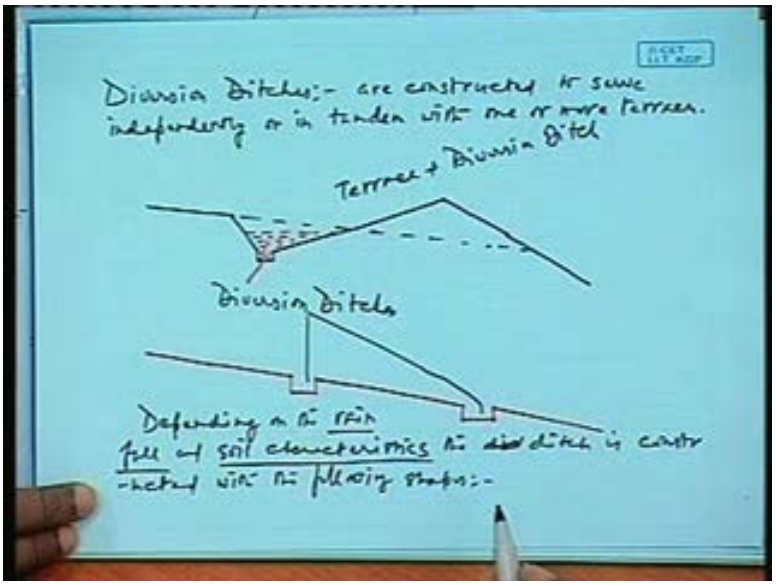

Now, having to say this, having to say this you know with these things in mind the next is the diversion ditches. After what is you know is mostly you know in cases of diversion ditches the examples of this generally either independent or you know connected with the terrace, the diversion ditches are constructed, diversion ditches are constructed, constructed to serve independently, are constructed to serve independently or in tandem with or in tandem with a terrace with one or more terraces. The usual structure is not much of a difference here, if you have already seen you know you say a typical broad based terrace, the diversion ditches or like this okay and if we see this you know the diversion ditches like this we have in places of say you know we can also keep a diversion ditch so that this is a, this is a, this is also, this is known as the diversion ditch. As against as I have said there may be only diversion ditches also, here in such cases say you know in a slope generally you have diversion ditches like this, all right.

So, this are, these are the diversion ditches, these are the diversion ditches which are, which are generally used in tandem with the terrace. This is a, the terrace and diversion ditch and this one is only diversion ditches, so you know this is, this is, this is also another method of, this another method of arresting, arresting water to flow. So, you can, you can make an I mean intermittent passages inside, inside the slope so that the water can be, water can be carried away, the water can be carried away. So, this is you know the construction is depending on, depending on the rainfall, depending on the rainfall and soil characteristic the ditch is constructed with the following shapes, the following shapes like this. Depending on the rainfall and soil characteristics and the demand that is about the soil, about the demand of the ditch they are constructed with the following shapes, the following shapes are like this.

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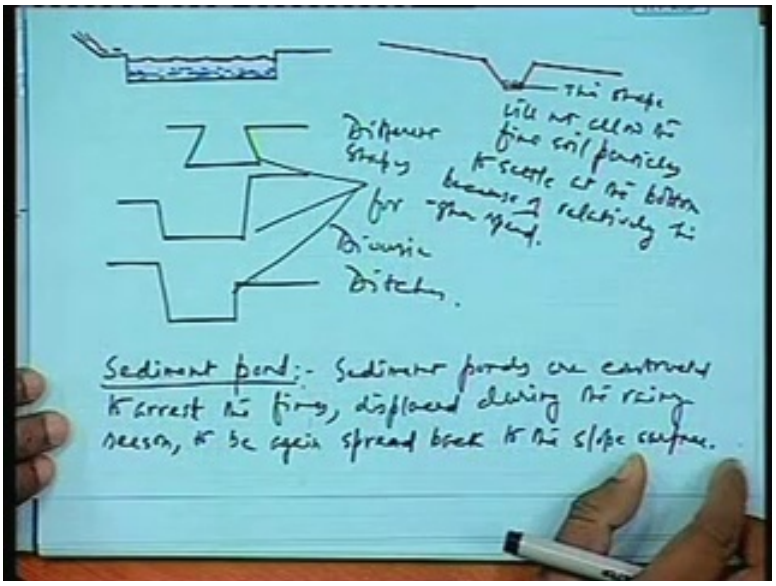

The shapes are you know generally a wide ditch, wide ditch would be able to you know in case of, in case of the soil being, in case of you know this lot of fine soil existent in the soil, in the slope itself. So, here we would generally try to reduce the velocity of the water. So, this the water that is sorry the water that is coming out say water that is coming out through this which is coming, coming from the surface, from this slopes, these slopes this water would be the velocity should be reduced. So, the velocity should be reduced means we will be finding finer particles to settle, finer particles to settle here, this is where the finer be settling here. If we are trying to, if you are trying to say trying to put all this, all the fine particles, all the fine particles, all the fine particles to a particular storage at the bottom you know I'll think talk about say something like this, if it is… So, here what we are interested is the sediment to be carried away, the sediment to be carried away. So, as a result of that you would expect say here there would be a relatively higher velocity at the, at the bottom and so this would not allow, this shape will not allow, allow the fine particles, particles to settle, the fine particles to settle at the bottom because of relatively higher speed. This shape will not allow the fine particles to settle, fine particles to settle at the bottom because of relatively higher speed. So, the fine particles would not be collected on the terrace or on the diversion ditches right on the diversion, they would be generally carried away.

So, there are different types of shapes, there are other types of shapes like you know where it might also have a shape like this then you know this kind of shapes are also common where this is one side there would be more and the other or say this one. So, different types of shapes that we can generally find say different shapes for diversion ditches, different shapes for diversion ditches right apart from that, apart from that in another very typical I mean typically important you know as mechanical soil erosion control method is say sediment pond, the sediment pond. The construction of the sediment pond is the, the sediment ponds are, sediment ponds are constructed to arrest the fines, displaced during the rainy season, rainy season, sediment ponds are constructed to arrest the fines, displaced during the rainy season to be again spread back to the slope surface, to the slope surface. Sediment ponds are constructed to arrest the fines

displaced during the rainy season to be again spread back to the slope surface, to be again spread back to the slope surface, to be again spread back to the, spread back to the slope surface okay.

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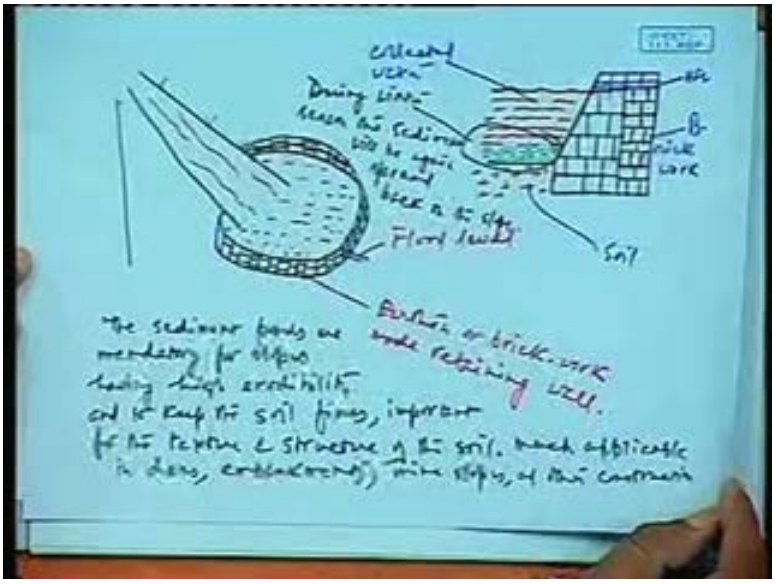

Now this is what you know we'll just see how this sediment ponds are constructed, how these sediment ponds are constructed. The typical sediment pond is like this which is just like the sediment ponds are you see across the slope, if you just see this is generally say across this slope you know sparsely vegetated soil slopes like this. You find here that this one is okay you see you are, you are going to see only one face of the slope just this is one face of the slope. You see the slope would be you know you are not been, you see this is mostly the slope like this you know the slope spreading up, this spreading up then okay just for that case you know just consider that the slope the sediment ponds is like this. Here the sediment pond is constructed like this, this is what, okay. So, this you know the water across the water coming, coming from you know this coming from across the slope, coming from across the slope gets collected here and this is what is a sediment pond you know where you have a flood level, this is an earthen or made retaining wall, brick work made retaining wall and as you can see here, as you can see this is how it would look like say you know if it is, it is, it can be seen like this all right. So, here you see this say this one is, this one is you know typical say a sediment like this. So, here this one is the soil surface the brick work, brick work this is collected water, collected water and certainly as you can see the collected water there would be one HFL highest flood level after which you would allow the water to pass through the sediment pond.

So, here this, this the sediment that is collected, the sediment that is collected which is a, which is of considerable, which is considerable in amount. This sediment would be again during rainy season, during winter season the sediment would be, would be again spread back on the slope, spread back on the slope, the spread back on the slope. So, sediment ponds you know this is sediment ponds are of a great use nowadays, this sediment ponds are finding wide application and this we can see that you know this particularly in situation like, the situation this you just write down a few lines on this. The sediment ponds are mandatory for slopes having high

erodibility, high erodibility, mandatory for slopes having high erodibility and to keep the soil fines important for the texture and structure of the soil, texture of the, texture and structure of the soil.

So, the sediment ponds are, sediment ponds are quite in use important for the texture and structure of the soil. The sediment ponds are in great use, sediment ponds are nowadays almost always used in various constructions like you know very popular or much applicable, much applicable, much applicable in dams, dams, embankments, mine slopes, mine slopes and then say and other construction projects, other construction projects. This much applicable, this are, the sediment ponds are quite in great use actually in great use in areas like dams, embankments, mine slopes other constructions, construction activities like construction activities, activities like, like road making etc.

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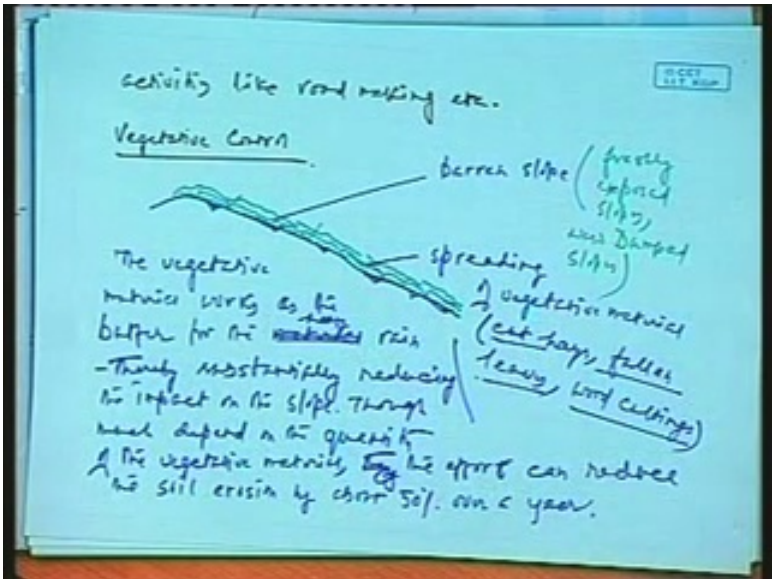

The sediment ponds you know serve a great purpose, all these serve a great purpose you know help in greatly reducing, greatly reducing the, greatly reducing the, the erodibility of soil and there by reduces the impact of rainfall essentially rainfall on the slope to reduce the, to reduce the erosion, to reduce the erosion as to arrest the fine particles. This remains you know these are very important structures, they are greatly used I mean it's not to say you know in almost all cases as you go towards you know in a construction side or go towards a travel by a road side if you just observe the similar kind of structures are on say structures are very much in great use.

Mostly, the sediment ponds and catchment ponds all this kinds of things you would very well see you know mostly in the mountainous road sides and greatly improve the soil slope helps in keeping the soil, keeping the slope dry, helps in keeping the you know to helps in reducing the failure of slopes various other benefits can be obtained with the construction of this kind of structures mostly in the slopes, okay. You come back to the next class after 5 minutes break, right okay.

Preview of next lecture:

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Okay, before we actually go into this detail of this soil erosion prediction, we would need to discuss something more about this mechanical soil erosion control and a continuation of that.

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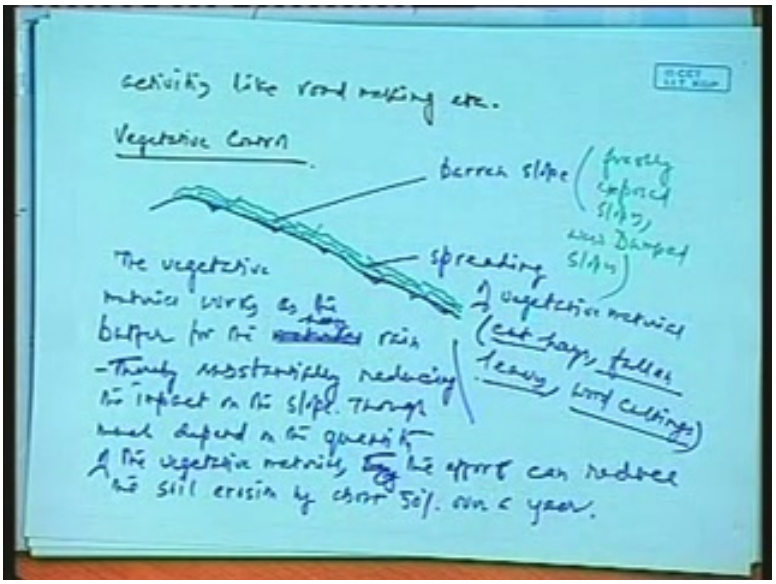

This is, we call this as in the next one is apart from this mechanical soil erosion control, we also use another control for to stop and check erosion, to stop and check erosion like this. This is called, this is vegetative, vegetative control, vegetative control, the vegetative controls are like this I mean you know you say you know if you are just trying to observe a particularly a slope,

particularly a barren slope how it looks like so you know here say here if it is a slope like this, say here the slope you know is broken at places like this.

The slopes that we generally observe here what is this slope, when it is completely denuded, completely barren. So, this is barren slope, barren slope means you don't have, you don't have any large plants, you have small plants shrubs like this structures not even that mostly this barren slope you will find near you know this freshly, freshly exposed, freshly exposed, freshly exposed slopes, freshly exposed slopes, new dumped slopes where are there is no, practically no vegetative cover, practically no vegetative cover, in such cases what we generally try to do is we have also found talked about this earlier what we do is generally we try to spread some vegetative material on the surface of the slope, on the surface of the slopes.

What are this vegetative materials? These vegetative materials depending on, depending on the availability and the requirement, we generally spread vegetative material, spreading of vegetative… What are these vegetative materials? Mostly, cut hays, fallen leaves, fallen leaves say, say wood cuttings are generally spread all over the, all over the barren surface of the slope, all over the barren surface of the slopes. So, this say they work the, the material works as, works as the buffer for, buffer for the rain, buffer for the rain, buffer for the heavy rain, heavy rain thereby, thereby substantially, substantially reducing, thereby substantially reducing the impact on the slope, impact on the slope though much depend on the quantity, though much depend on the quantity of the vegetative material they can, they can the, the effort can reduce, the effort can reduce the soil erosion by about, by about 50% over a year, by about 50% by about over a year. So, much depends on the, much depends on the vegetative material works as the buffer for the heavy rain thereby substantially reducing the impact of the slope though much depend on the quantity of the vegetative material, the effort can reduce the soil erosion by about 50% over a year.

So, this is also another very standard technique, this is also very standard technique of you know is just in case you know just to suggest you another important thing is that when you are, we generally cut grasses you know in our gardens or any other places or collect leaves they can be a very important resource. This can be very important resource particularly in areas where there are very little vegetative growth, this vegetative growth and very little rainfall. This kind of, this kind of material if it is spread over a large surface area they can substantially improve the quality of the soil over time and not only that can reduce erosion to a substantial amount over the years. So, having to say this, having to say all this thing now, we can see that you know this is how this the erosion can be checked and controlled and at the same time you know there is a necessity for in most cases for how much this would…