Fundamentals of Environmental Pollution and Control
Prof. Jayanta Bhattacharya
Department of Mining Engineering
Indian Institute of Technology, Kharagpur
Lecture No. # 27
Universal Soil Loss Equation

Okay, so today we start this you know we have been discussing about universal soil loss equation.

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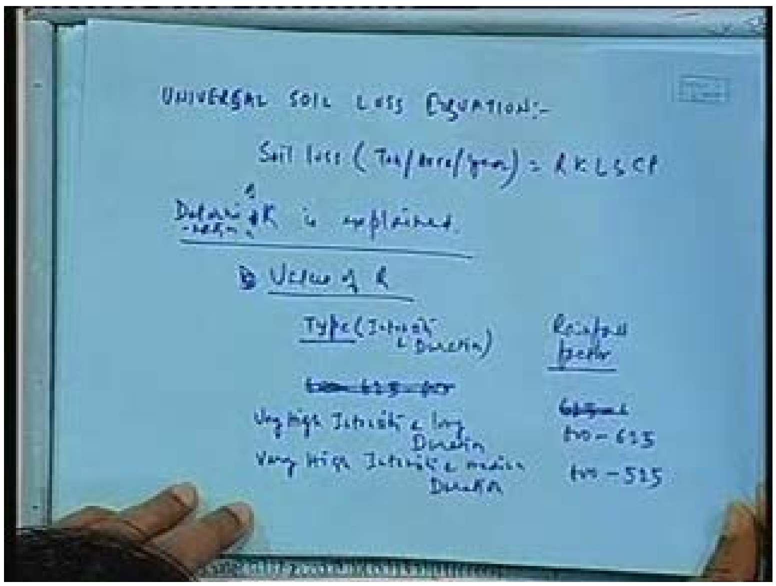

The universal soil loss equation that is you know we have started the discussion on, we said that you know in any case we can estimate the soil loss, soil loss ton per acre per year by multiplication of number of factor RKLSCP. We have already explained that you know this R means the rainfall factor, K is a, K is the soil erodibility factor, L is a length factor, S is this is, this the steepness factor or slope factor that we call it and the C is the vegetation factor and P is the mechanical soil erosion control factor. So, having said this you know we were discussing about how to use this. So, I have already explained you know this is in the, in the class last you know I was just talking about you know what to be how to actually determine the different say different rainfall factor. This is we have already explained K is determination of K is explained, determination of, determination of K is explained. I have told you know I will again come back to that anyway but before that we start into…So, you know the R, value of R, I said that you know in most cases we use the isoerodents, isoerodents that we use that this isoerodents you know they have a large table.

So, you know herein we will just try to bring this you know in, is in a smaller values in a like in cases like India you know the type I say the type and value of R say type you know the type is intensity and duration of rainfall, duration of rainfall in a geographical area, intensity and duration of rainfall in a geographical area and the second one is this one is rainfall factor, the rainfall factor, the rainfall factor. Here the one we generally explained here is this you know to start with say between say the higher values that you know 600, so say 625, say 625 to 600 I am sorry let me put it here 625 okay, 600 to 625. Here this one is try to understand this high intensity, very high intensity and long duration, very high intensity and long duration rainfall areas. The factor that we use is the rainfall factor is about to 600 to 625. Then it comes to say very high, very high intensity and medium duration, medium duration, the value we should be working on is between, is between say 600 to 525, okay.

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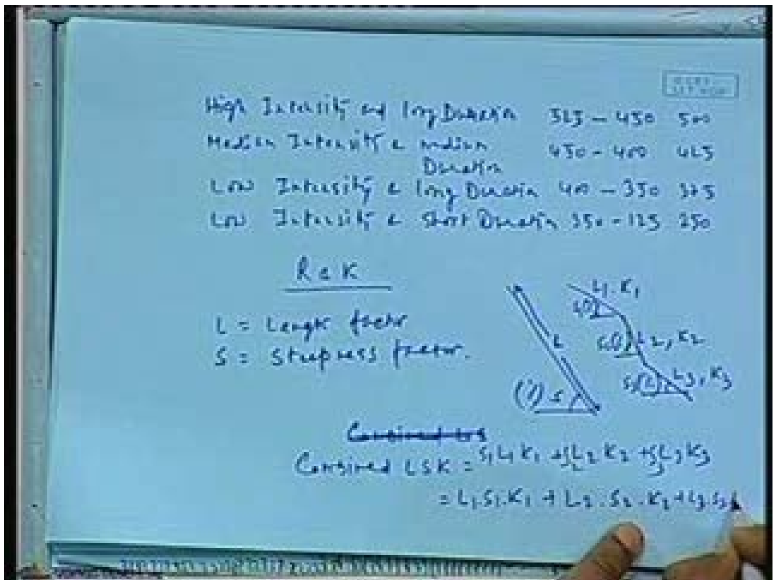

Similarly, similarly, so as you can further go on very high intensity and say medium, medium duration this is then you can see high intensity, high intensity and long duration, high intensity and long duration, high intensity and long duration we find these values to be, the values would be about between 525, it's okay here okay 525 to we have about 450, right. So, this is then comes is medium high, medium intensity and medium duration, medium intensity and medium duration. The value would be between say this one is 450, 450 to about say 400, 400 you see not necessarily in the same proportion it would reduce. So, similarly this is says, say low intensity and long duration, low intensity rain but for a long duration in such cases we can have it between 400 to, 400 to 350 okay and here is low intensity long duration there is then this is low intensity and short duration.

So, duration we will have mostly the value between say 350 to 125. So, in cases you know this is you can, you can always use the medium values medium, medium values increases like this. So, in cases here you can see for your case, for your case you know this is usual value that we should usual value with that we should take is between you know 610 then it is 5 say 570, 570 then this values can be between 500, 425, 375 and also say 200, say 250 okay. So, here you know these are the values you can start with to calculate, so this is a rainfall factor, so we have come to know that you know how so you know what we say you know is generally suppose if it is given like in a, in a rainfall area say a particularly in a rainfall area, in a geographical rainfall area say you know I was explaining yesterday that you know we generally go by an isoerodents like you know we find that you know in India generally say the Nicobar area, this particularly Andaman Nicobar area would be having the highest rainfall area, mostly highest rainfall. Then as we go towards west there rainfall would come down.

So, similarly what we use this from this isoerodents, we can find out the value of this rainfall factor, the rainfall factors. So, suppose a, in a if it is given in a problem or any, any other places if you have to start with the value, you just say high intensity and long duration rainfall you should select the value of R as equal to 500. This is the starting value we start with, so this is we have already found out we have already found out R and K. We have already, we have already we have already found out R and K. Now, having to say this you know R and K what we further get here is that this is the R and K once it is found out then the next is length, length factor S is the steepness factor. Other things being same you know you just you know if we just the nomograph that I have given to you, you just see here say these values here if you can finally, so let me explain here from this the topographic factor LS the values of topographic factor, the values of topographic factor L and S.

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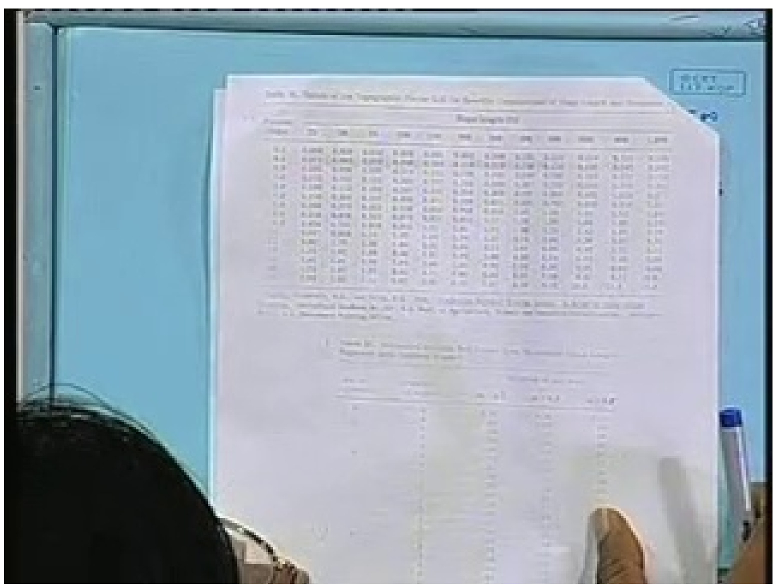

You see here suppose you have you know all these values you know this one is in steel in agricultural engineering, you know number of things are in steel in feet. So, you find it like this say here suppose the slope length, the slope length is, slope length along the slope it is about say 300 feet and having a percent slope say about 10 okay, say percent slope about 10 so you can find out the value at see L into S, L into S equal to 2.37 okay. Now here is this is what in, what is interesting here is say is just you in other cases you know in case of C and P, generally if no, if they are not applied that is the vegetative factor is not applied neither the mechanical soil erosion control factor being applied, in such cases the values are 1 but here you all the while you can see the values can range from say highly fractional values like say you know 0.1 even 0.06 to start with and go up to 12.9.

So, remember this so you know L and S together can be L and S can be the values can be, can fluctuate from 0.06 to 12.9 depending on the situation. Now what happens is apart from this there are few other things to be explained here you say if you so if L is given, S is given you can find out the value of L and S, okay. Now having to say this, having to say this, now what happens here is in cases like that you know if it is an uniform slope, you can find out the L, you can find out the L like this, you can find out the L like this, okay and you know that you know the slope S factor you can find out from this S factor percent so on from the percent slope you find out the S factor, L into S.

In situations like where the slopes are, slopes are you know in sub plots like this where this is, this is L 1, L 2, L 3 and each of them say having a different S and different S as you can see percent S, S, this is percent S 1, this is percent S 2, this is S 3, S 3. In such cases we have to find out the combined LS for the slope, combined LS, combined LS in fact it’s not only combined LS it is you know sometime this if it is having they the, this soil erodibility factor K 1 say this K 1 having this one having K 2, K 3 depending on the different soil types remember this. This is the slope parameter L 1 and S 1, length of the slope and the gradient of the slope. K 1 is the soil erodibility factor depending on the soil structure, soil texture and permeability.

So, if these things are variable so in such cases we can find out combined LSK as L 1 K 1 plus L 2 K 2 plus L 3 K 3, okay L 2 K 3 and this is LSK, LS this okay, I put the S 1 here S 2 S 3. So, here or else we can even conventionally you can write L 1 S 1 K 1, this is all multiplied plus L 2 S 2 K 2 plus L 3 L 3 S 3 K 3 okay. So, here this is what is the combined LSK.

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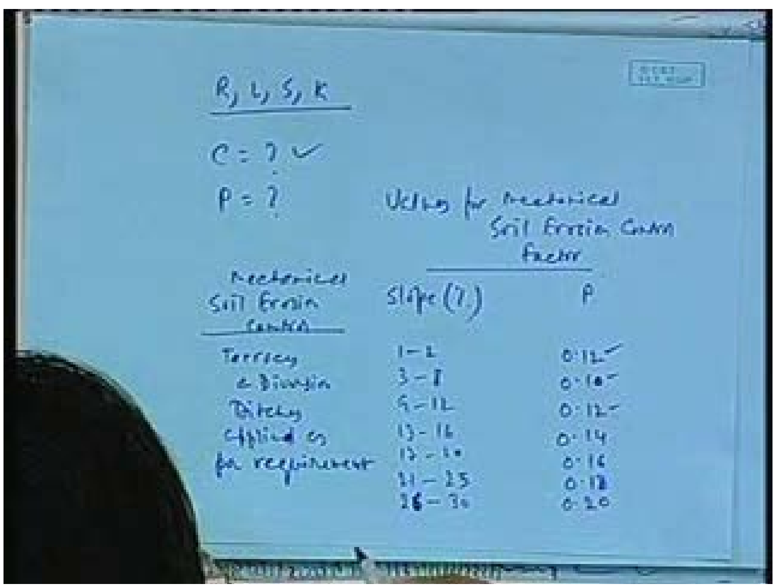

So, we have by now we have found out say four factors they impart this four factors we have come to know that is R we have found out R L S K and their combined effect, okay. Now, the two things more we can have to find out what is C, what is P, what is C and what is P. So, you can this you know apart from you know not going into the much of that, much of the other things about LSCP, let us you know the first part for the CP.

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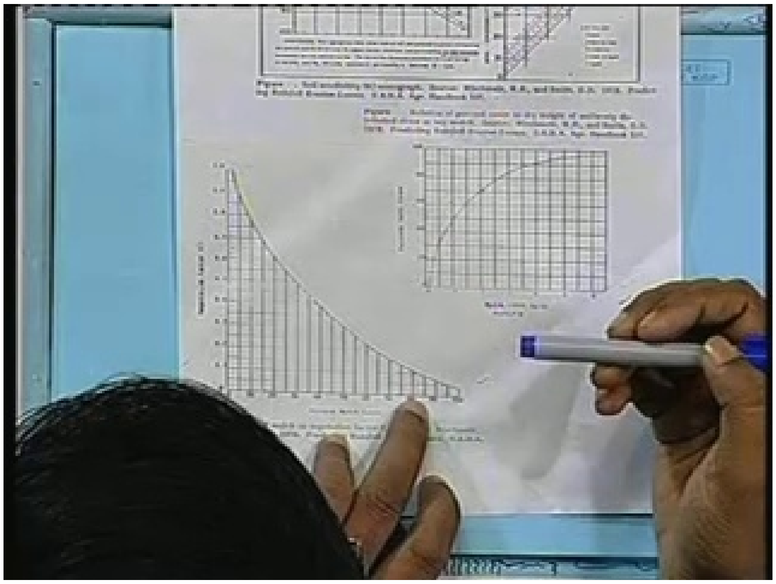

What we find out here is let us see this plot here okay if we have brought it out, so here itself you just see this. What is the first of all, what is this, the mulch you know if you remember if you, if you do not remember this is the mulch is I said that the vegetative material that would be spread on the slope, that would be spread on the slope. The mulch is this is, as I have said wood cuttings it can be, it can be sometime say raw hay, straw that is you know hays after the paddy is cut, all these staff would be generally spread on to the soil slope surface. This is just to reduce I have explained that you know the importance of vegetative material in reducing the erosion. So, this mulch you know this is generally put in terms of say 1000 ton, 1000 pound per acre, 1000 pound per acre.

So, suppose for a slope we have spread, we have spread for a slope, we have spread say 3000 pound per acre mulch on top of the slope surface, on top of the soil slopes. So, you know this is 2 3, you can see this see here 0 1 2 3 so you know 3 say 3000 pounds of material has been spread on the soil surface over an acre of area in such cases this percent soil cover have to be found out first. So, here it can take the percent soil cover becomes almost 80 say let us keep this value as 79. If you see this, if try to see this again according to this plot this is a where it is say about say 3, so it is more than sorry it is more than 80 here yeah say 82 or 84 like this okay 84, 84, if this is 84 right, this 84 has to be again brought back here this is the percent, percent, percent mulch cover or percent soil cover, this one is 84 okay. You bring it out the 84, this becomes the vegetative factors become point say 0.075 or 0.078. Isn't it? Say at 80 it is close to 0.1, so the value that I said say about 84, it would be about point say 0.8 or 0.9 like this, sorry 0.08 or 0.08 or 0.09 like this. So, this way we can find out the value of this vegetative factor say for a lesser value, say you know if we have said we have spread mulches 1000 pound per acre, per acre in such cases you find that the soil coverage is only about percent soil coverage about 50. This 50, if you just plot it with these 50 here, the vegetative factors become 0.3, 0.3. So, what is interesting here to observe is or important for all of us that is when, when no soil, no mulching, nothing is being added, nothing is being added the vegetative factor is 1. When something is being added, the value is consistently going down.

Yeah so, here this is, this has to be watched and noticed on all the time, say here this is what is, how we can find out the vegetative factor C. This is how we find out the vegetative factor C. So, we have also found out C, we have also found out the way we have also known the way the C can be found out, with we have also known the way the C can be found out. Apart from that then the next one is you know our values for mechanical soil erosion control factor, the mechanical soil erosion control factor, the mechanical soil erosion control factor is can be you know is you can I think you know you somewhat not clearly visible but you can see this.

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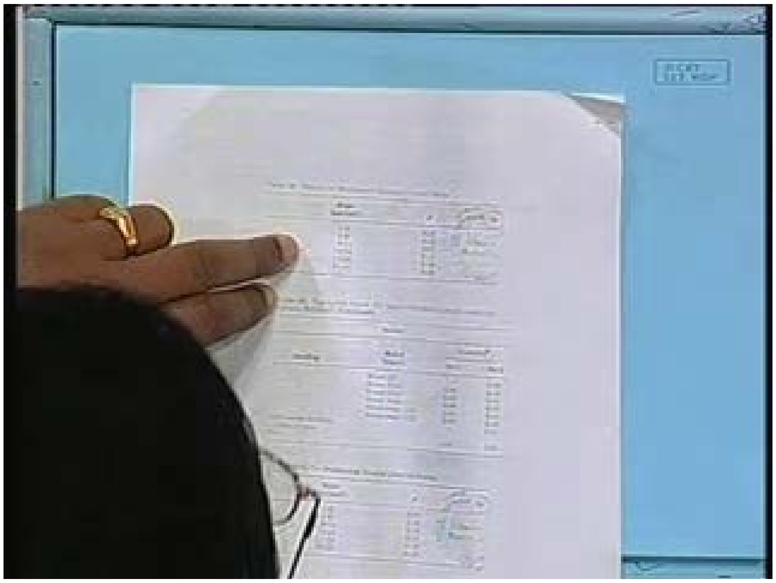

If you have, if you don't have this, this values with you let me write down the values for you. The values for mechanical soil erosion control factor is slope percentage and P, mechanical soil erosion control, the soil and this one is the value of P. So, the mechanical soil erosion control this say you know say for this what we have been trying to do here is this say we are using, we are using say we are using say you know say typical the terraces and diversion ditches.

This is the mechanical soil erosion control, we have used this terraces and diversion ditches applied as per requirement, as per requirement. If we have done so terraces and diversion ditches, I have explained this in the last classes what are all these, terraces and diversion ditches, if they are applied say for a 1 to 2% slope or say 3 to 8% slope 9 to 12, 13, 13 to 16, 17 to 20, 21 to 25, 21 to 25 say and then say 25, 25 to say 26 to, 26 to say 30 and 26 to 30. So, this if you can use this values now see here the value of P here is 0.12, 0.10, 0.12 again, 0.14, 0.16, 0.18 and this one would be 0.2. What it means here is this you know this factors you know when there is no mechanicals are first one is 0.12. Yes then again 0.10 then again 0.12. So, here you know this it goes on to say the effectivity is not similar, is effectivity is not similar, effectivity you know varies according to the slope. Here, this one is zero 1.2 if no, if no soil erosion control, no soil erosion control then in case of this is you have taken this down this table in case, in case you have not, in case in case no mechanical soil erosion control has been made, the value is, value of P is equal to 1.

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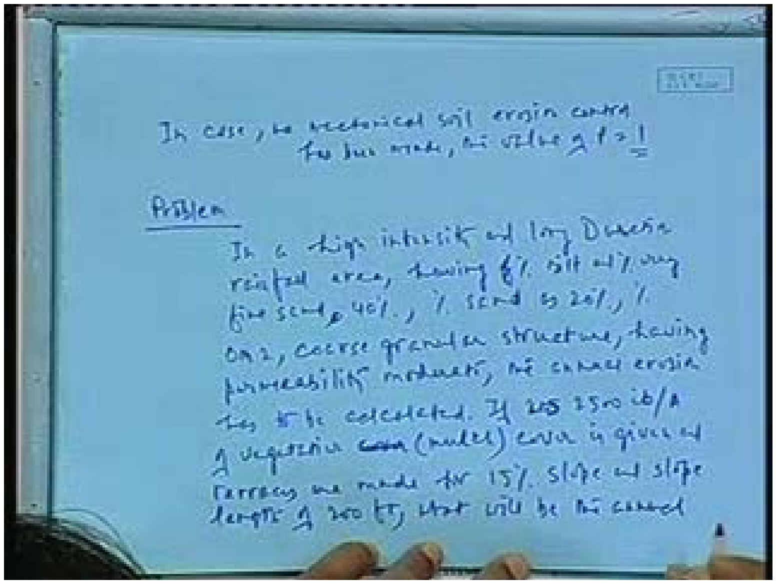

Remember this, it never become 0 as such, 0 means everything comes to 0. It's nothing like that if no mechanical soil erosion control has been made, the value of P is equal to 1. Now, let us see a problem, let us see a problem. Say, you know now say a, say a problem or in a problem or you know assessment of a particular situation, assessment of a particular situation. Let us take a problem, situation like this in a, in a moderately, in a long high intensity, in a high intensity, in a high intensity and long duration, long duration rainfall area, in a high intensity long duration rainfall area having, having, having percent, having percent silt, having percent silt and percent very fine sand both this percentage together percent silt and this is additive actually, percent silt plus percent very fine sand having and of say, of say 30% of say 40% percent sand, percent sand as percent sand, as percent sand as 20%, percent sand as 20% with organic moisture, with organic matter with a and percentage of organic matter or percentage of organic matter being say 2, 2, percentage of organic matter is equal 2.

Then very fine say you know this kind of soil very fine sands you know it would be almost coarse granular, coarse granular structure, coarse granular structure, coarse granular structure and having, having, having and having permeability, permeability moderate, annual erosion has to be, to be calculated. If 2.5 sorry, if 2 5 0 0 pound per acre of vegetative cover, vegetative cover or so the or the mulch cover vegetative or mulch cover is given and terraces are made for 15% slope and slope length, slope length of, slope length of say slope length of 200 feet, what will be the annual erosion by universal soil loss equation, by universal soil loss equation, okay.

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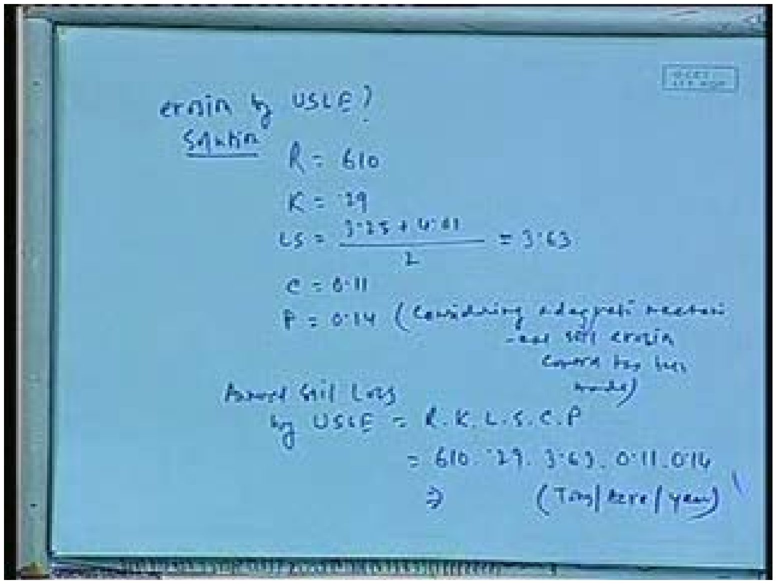

So, remember this is a barren slope. This is generally a barrens slope say you know is particularly freshly exposed soil like you know what you find you know dams or say you know fresh dams. What we observe there or if we have not made this, this you know we have not done terracing, we have not done anything like that and if we have done things like that you know what is the effect. Say, here this so what we are now you see you know how we are going to find this out say high intensity, long duration rainfall area what would be R solution 6, 6 1 0, 6 1 0 all right this is the 6 1 0 this is the basic value that we are just trying to find out say you know this is K what would be K find out K.

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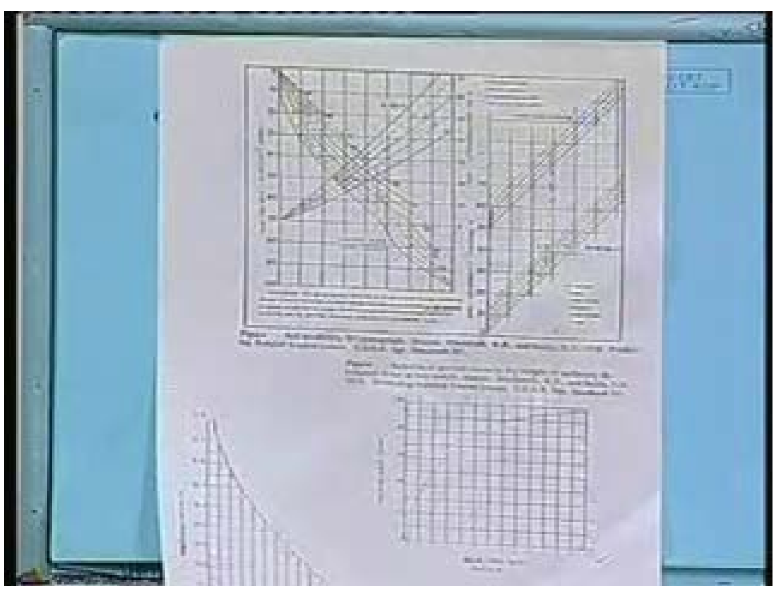

See, you know this as I have explained in the yesterday's class, let me again begin this. See, this K here what we have said is silt and very fine sand has 40%, okay. So, you see this plot here 40% here you just see this very this is 40% and we have sand has 20%, sand has 20%, this is the 20% curve for sand, this is 20. So, here 40 is going to be connected here in this case, okay. It is, it is being connected somewhere here 40 and this one you can see this okay. Now, this is not enough, now this is not enough then from here from this point where it has connected from the point where it is connected you have to combine these two, you have to combine these two you know you have to find out if you just extrapolate this value, you have to find out the value of at organic moisture. What is the value at that organic moisture is sorry organic matter that I have said is 2, so this 2 if you just connect this line 2, it comes to the first approximation value of above 30. Isn't it? So, what you have done is let me repeat it again. This is 40, this is 40 is this, this one is the 20 here that I have said, so 40 and 20 getting connected here at this point we have just extrapolated it to 0.3, 0.3, 0.3 is a approximate value of K. This is approximate value of K, this 0.3 should be further extended here so for a, for fiber refinement of this.

See, now here this one is 0.3, this 0.3 is finally getting connected you know I said the structure of the soil as I have said is course granular. Isn't it, 3? So, these value of three here it comes to 3, so here this is where this value is this is where it is getting connected. See, this 3 getting straight away connected at 3 here, at the intersection point with the dotted line. Can you see? 0.781, yeah. So, here from this at this point say here if you just try to observe this say you know these three, these three gets connected with three, three media, this one three medium or coarse granular three medium or coarse granular just about, just about this, just about this point say this is three and this one, isn't it?

Yes sir. If you just find the point say if you just drop it down, if you just drop it down in a similar line like this, we have said that the permeability is three moderate. Isn't it? See, this permeability is three means this firm line here, this firm line here say about this three. So, this three if this three you know it would again come back see about 0.29 or 0.28 would be the value for the K. We take another left turn from here, so you find out soil permeability, soil erodibility factor K. see, let me explain you this first. The first this the value that we have got 0.3 is the first approximation factor K that can be further corrected with the use of this structure and the permeability and whatever value we get after that would be close to this 0.3 but would be somewhat different say it will, it is 0.3 here it may be 0.29 or it may be 0.31 like this. So, this is the value of K that we have to accept, that is the value of K we have to accept. So, the corrected value of K has to be accepted. So, this is called the soil erodibility factor that we'll find out and we will also find out the value of K. So, here it is say the soil erodibility factor that we have to found out here is about say 0.29, 0.29 okay, all right. Now, here say RK then you know we find out L and S.

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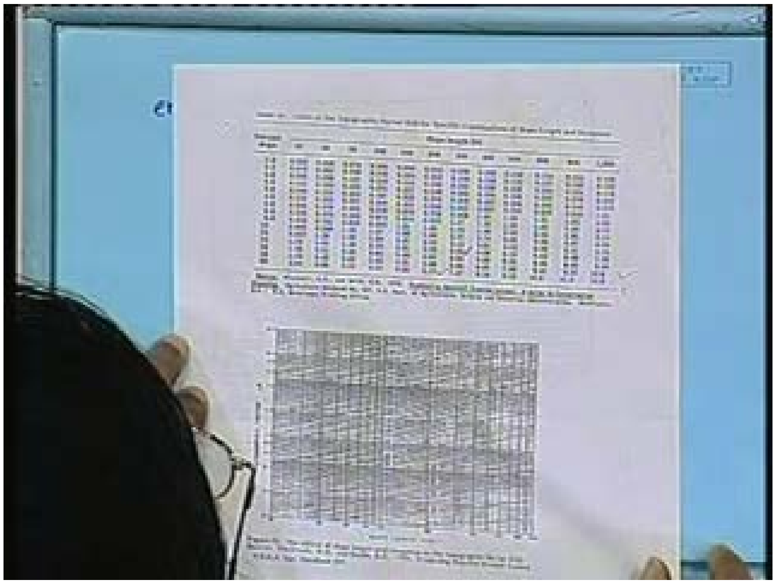

L and S you know in such cases we have only used only one slope, so you know, you know to have a very know you know have to be much worried about this, so percent slope is about 16 says I said 15% let us say about 15, say 15 and this one is we have said about 200 feet. So, 15 and 200 feet, the, this, the LS becomes 4.01. Isn't it? Yes sir, it is 4.01, 200 here, 200 here and 200 here this value becomes 200 here and 16 which is about 4.01, 4.01 which is about 4.01.

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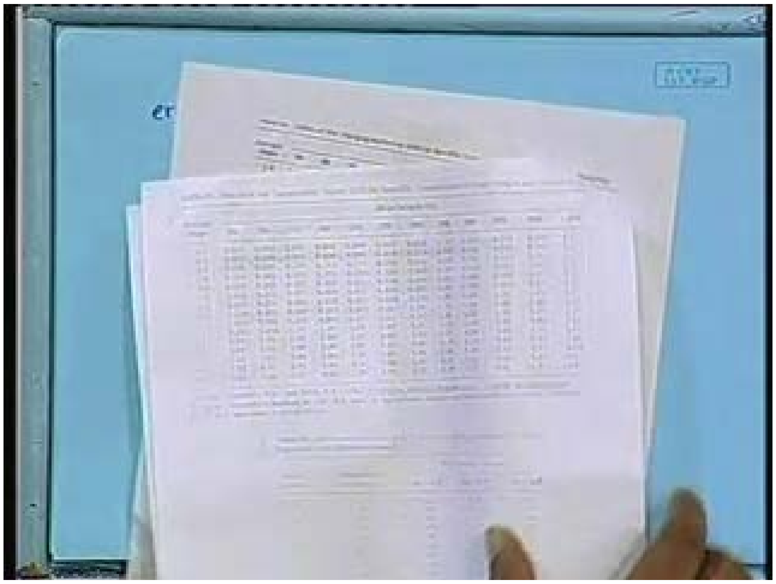

If you just see this again in this, in this you know relatively somewhat larger than this so 16 and this is 4.01 so you know it is not 16 in our case, so let us consider that to be say about say 3 between 3.25 and 4.01, the value between somewhere between that. So, you know it is about coming out to be about say 75 say you know about 35 if you can add 3.6 okay. So, we find this as LS as equal to, as I have said 3.25 plus 4.01 divided by 2. So, it is about coming to say four point, 7.25 that is about 3.6, is it? 3.6 3 about that? 3.56 sir, no 3.25, 3.25 and 4.01 divided by 2 so it comes to about, about say three point, if we get a better value we can find that out yes, yes, okay.

Now, the C, next is C. How we have, I have already explained you to find out the value of C here. The C is this, C is this, C is a percentage mulch cover, percentage say the first one is I have said the mulch that has been spread on that effective mulch that has been spread is about 2500 pound per acre. So, it is here 2000 pound, this is the value, this is the point you know where you find 2.5. Yes sir okay, so 2.5 means 2.5 would means about 80% of the percent soil cover. Yes sir, this 80% of the soil cover as we come down here again about 80, we found the value about 0.1, 0.1, okay. So, C is 0.11 okay. Now, next is P. We said that excuse me, we said that you know, that you know there is you know certain kind of say, say a mechanical soil erosion control has been made or is considering that you know the mechanical soil erosion control measures have been taken, measure have been taken for this slope which is about say so the slope is, the slope we have said is this is about 15% slope, for this 15% slope you can see this the value, this is between three point 0.14, considering that mechanical soil erosion control factors have been used that is mechanical soil erosion control has been used, considering adequate has been made, so this P becomes 0.14.

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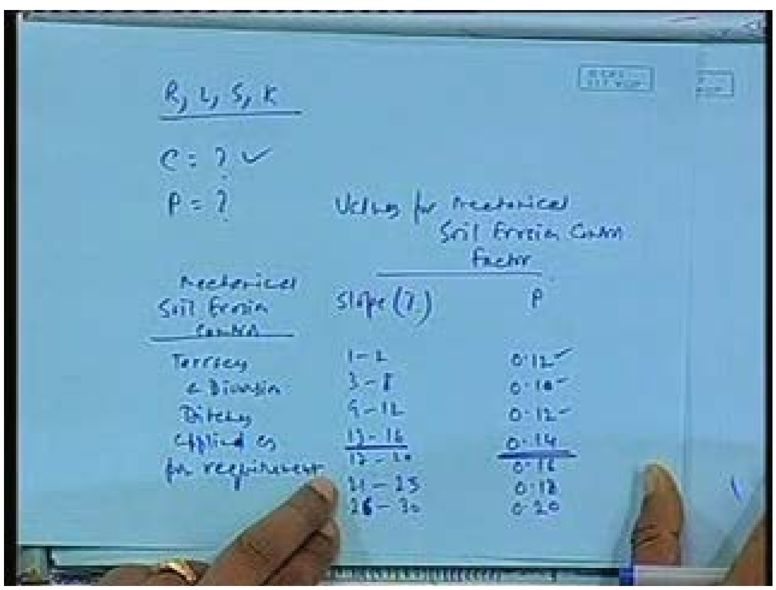

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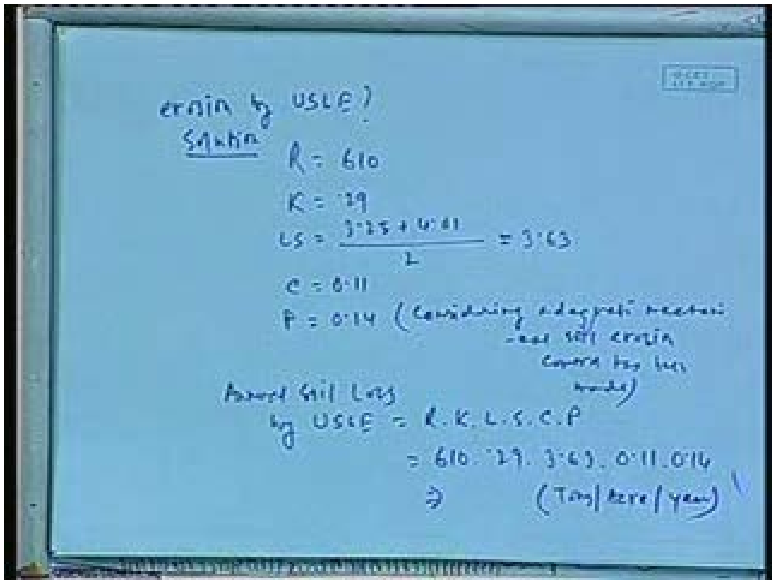

So, if you multiply this now, so annual, annual soil loss by universal soil loss equation, universal soil loss equation is RKLSCP, RKLSCP. So, this one is R is 610, K is we can find 0.29, this is LS is 3.63 multiplied by 0.11 into 0.14. So, this the value that is what we get say you know you can find out, the value is, this one is the value whatever the value that comes out in terms of tons per acre per year. We can compute, we can calculate the annual soil loss. This annual soil loss provides us the first estimate of how much soil loss is going to take place in a freshly exposed slope or a slope which has been standing for say 1 or 2 years and the diversion terraces and ditches are made. This gives a quite a good fast approximation, okay.

So, this has lot of engineering application actually, this is how we can find out the typical soil loss, expected soil loss in a, in a, in a slope, expected soil loss in a slope. So, with this the soil part is mostly covered you know for this course, there are few more things about soil to be told but you know considering that we don't have much time left, so you know here you know there are few other things you know for your general reading I would say you know please read a soil contamination, by soil contamination.

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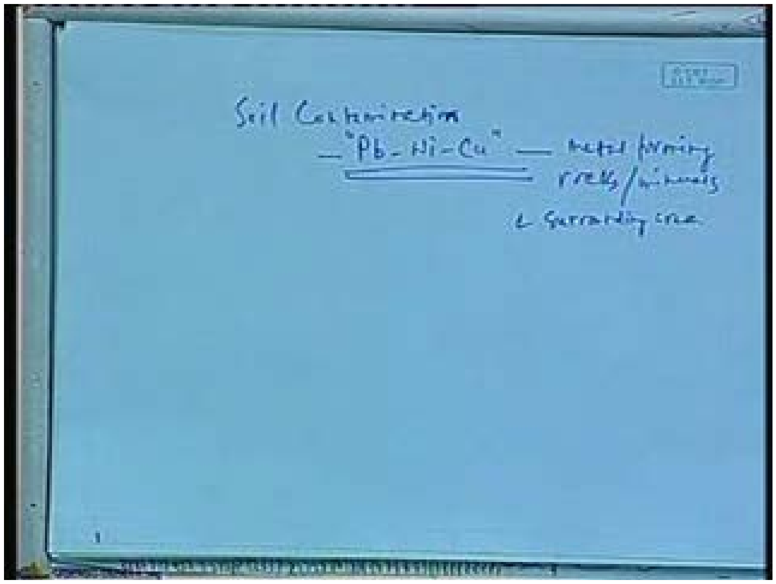

Soil contamination, the soil contamination particularly of tired of metals that we are generally very you know we remain Ni and copper. This is also a great problem in most of the construction areas, mining areas, the enriched percentage is of lead, nickel and copper particularly in say metal forming, metal forming, rocks and minerals and surrounding area okay. I would just you know ask you to suggest reading for this soil contamination is also a great part that needs to be explained okay. With this the soil part is covered you know so will come back to air pollution in the next class, okay. Thank you very much.