Hydraulics

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Module No. # 02

Uniform Flow

Lecture No. # 02

Uniform Flow Formula

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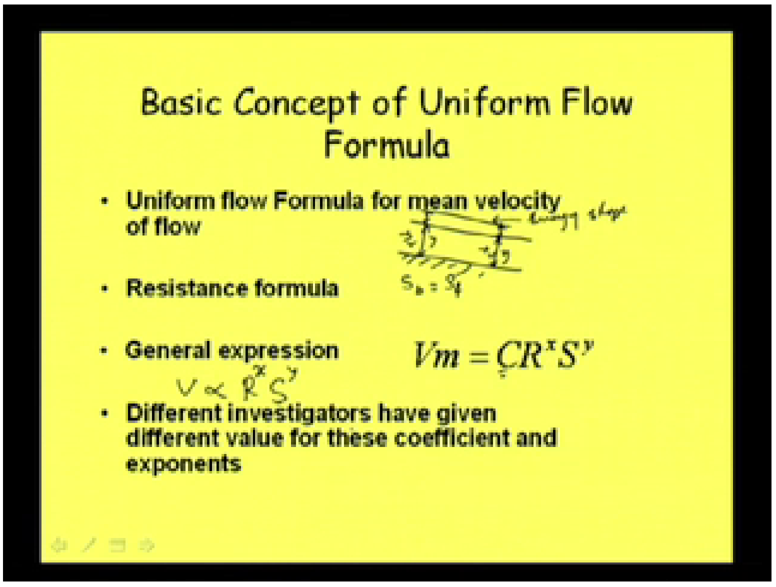

Intense flow formula in uniform flow well. First, let me go to the very basic concept of uniform flow formula, well. Again, when we say uniform flow formula, we always talk it in terms of mean velocity of flow. That is why, we are talking that uniform flow formula for mean velocity of flow; that means, by this formula or by this particular formula, what we are trying? We are trying to express the average velocity of the flow in a reach. Suppose in a reach the flow is uniform; in that reach, what is the average velocity of flow? A mean velocity flow and that we are trying to express in terms of some other channel parameter. Now, which are the parameter that are important and which are the parameter that is influencing the flow let us see one by one.

Well and as this relation of velocity is basically derived from the concept that, resistance offered is equal to the driving force. So, this formula is also called resistance flow formula, uniform flow formula well. Now, we can have a general expression for this resistance flow formula. For example, say when we talk about mean velocity v, then this mean velocity v you can say that, this will be proportional to the hydraulic radius r means, if hydraulic radius is more, proportional means I am not talking the directly proportional or something like that, if the hydraulic radius is more for a wide rectangular channel, earlier we did discuss that for a wide rectangular channel, this hydraulic radius is nothing but it becomes equivalent to depth.

So, when depth is more basically hydraulic radius become more, then, so this velocity will be more in that case, and in, if the slope of the channel slope of the channel S is more than also the velocity is more. Of course, how this V is related to R or how this velocity is related to S is a very critical question.

So, in general, we can say that this is related with an exponent x and say with an exponent y. So, velocity can be say it as proportional to hydraulic radius to the power x and it can be say it as proportional to slope, bed slope to the power y. Of course, when we are saying bed slope in uniform flow, we should remember one point that in uniform flow say, this is our depth.

So, everywhere our depth is same, everywhere our depth is same, and that is why velocity is also same, velocity is also same, and because of that, the energy or the kinetic energy also equal. So, if I add some kinetic energy component here and if join this line, then we did discuss earlier that this is the energy slope or friction slope, this is the energy slope or we can call friction slope and this is bed slope. Here, this is the kinetic energy component.

And then, we can see that as all these are equal, so for uniform flow actually the bed slope is equal to the friction slope bed slope is equal to the friction slope. And the formula as such we can express finally as, that the mean velocity of flow is equal to some coefficient C multiplied by R to the power x and slope to the power y and this slope is of course we talk about bed slope, and in fact, this bed slope is equal to friction slope in case of uniform flow.

Well, now, as these exponent and this coefficient different, we need to know and no definite analytical relation is there to derive this expression explicitly. The reason is that say depending on the bed roughness, depending on the side roughness, this x value can be different and the coefficient can be different and this co efficiency can be different. So, different investigators carried out experiment in the laboratory as well as they took some observed value of field.

So, some did experiment, extensive experiment and then observed value of the field were also taken and that way considering all these information, all these experience different investigators suggested different value for this coefficient, and as such based on these value of coefficient, we get several resistance flow formula or uniform flow formula. Now, the question is that which formula we should use or which formula is better. Well, now to know that it is better if we go to the history of development of resistance flow formula and that is why let us discuss some, at least some of the important formula that were developed and that were in use from say long back say it started in1769.

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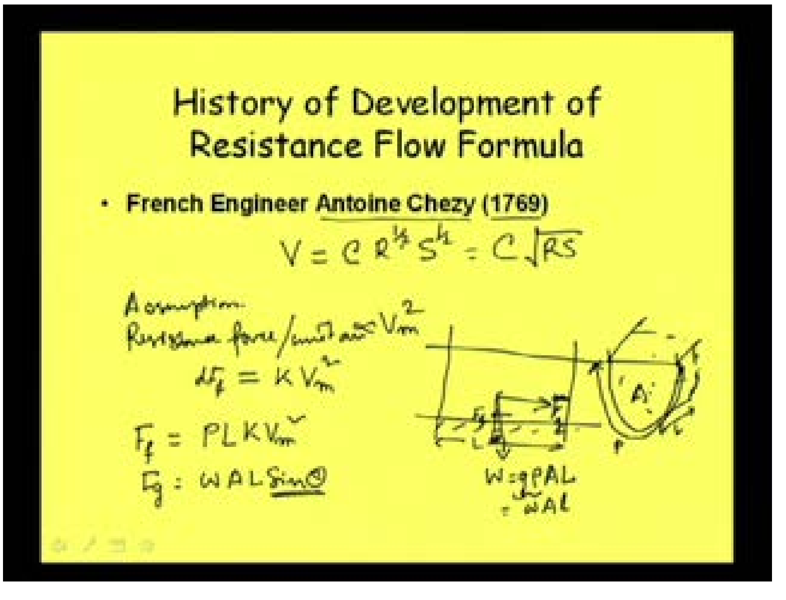

Well, we can say this first formula for resistance formula was developed in the, in France and it is French engineer Antoine Chezy. This name is very popular in hydraulic engineering - Chezy’s formula; it is known as Chezy’s formula, well. This Antoine Chezy he gave the formula as V is equal to that is the velocity is equal to a coefficient C and R to the power half; that means in his formula, this x value, this coefficient is half and then s to the power half.

So, both x and y that the exponent are having the value half. We can write it as C root over R S. This is the very popular and commonly uses expression of Chezy's formula, well, but for this formula, in fact we can have some analytical basis. Of course, we cannot exactly derive why it is half or these things, or if we can derive why it is half, then we need to have some assumption in that, but anyway, we can have some analytical basis that how this formula is coming.

Well, let me just go to some of these analytical basis. Well, for that, we make some assumption, we make some assumption. That assumption is that that mean velocity of flow is V m suppose and then the resistance force. Now, when we are saying resistance force, then always we are talking that it is the resistance offered from the side of the channel and bed of the channel well.

So, that means we can call that resistance force per unit area per unit surface area of resistance force we can assume that it is proportional to the velocity square. What we can say that resistance force per unit area, resistance force per unit area, is proportional to the mean velocity square; that means resistance force as such will not say that it is fix quantity. Suppose the given the surface, given the surface. This is the general convention of friction formula, that is, the given the surface, if you are trying to move in high speed, then resistance offer will also increase.

So, it increases square of the velocity. This is the assumption is being made. So, if I write these small forces as say d F f - F means I am writing frictional force and these symbol I am using to represent that it is a small forces per unit area - this can be written as equal to some coefficient say K and V m square because it is proportional to V m square.

Well, then writing this we can write that, say let me draw a channel, let me draw a channel, of this type. This is the channel say we are talking about a channel reach between this section to that section where the flow is uniform, and the sectional area is suppose this one, sectional area is suppose this one. Then total resistance force F f let me write it. So, total resistance force F f will be equal to, this is the resistance force per unit area.

So, total resistance force will definitely be equal to the total surface area that is in contact. Suppose if I take this sectional like that, then if this length is L, if this length is L, and this perimeter is from here to here is P. Suppose perimeter is P, then what we can write? The surface area will be P into L, this is what L is. So, P into L into the K V m square, that is, our total surface area multiplied by the resistance force per unit area. So, we are getting the frictional resistance.

Well, now, what is our basic relation? We know that for uniform flow condition that this resistance force must be equal to the force guiding the flow or driving the flow and that is nothing but equal to, this is suppose W weight of this and this length is nothing but this length, and if we put this sectional area as A, we are talking about some simple situation. So, this a is continues here and we are having the same sectional area or say we can talk in terms of considering average sectional area of this particular portion and then suppose we can write.

So, what will be the weight of this particular component? It will be say this sectional. What is the volume? Say sectional area multiplied by the length, this sectional area multiplied by the length. This will give me the volume, this will give me the volume, and then, weight is equal to, say actually mass is equal to row, we need to multiplied this by row and then to weight we multiply it by g. So, and this row g we can write as W A L; this is the unit weight. So, unit weight into A into L this is the united, but this will be the vertical component. Then there is actually we are talking about the force in this direction.

So, if the this angle is theta, then our interest is this force, our interest is this force; force in the direction, force acting in the gravity force component of gravity force acting in the direction of flow. So, this is what our interest, well. So, this force we can write as F g that we can write as W A L into sin theta because we are talking about this direction.

Now, let me go to the next slide that these, here we can make some assumption that sin theta if it is very small, sin theta if it is very small, now why this analytical derivation is important, because once we do this analytical deviation and then we will be knowing that where we have meet some assumption, and when we know that where we have meet some assumption and then we know that what are the limitation of this formula well.

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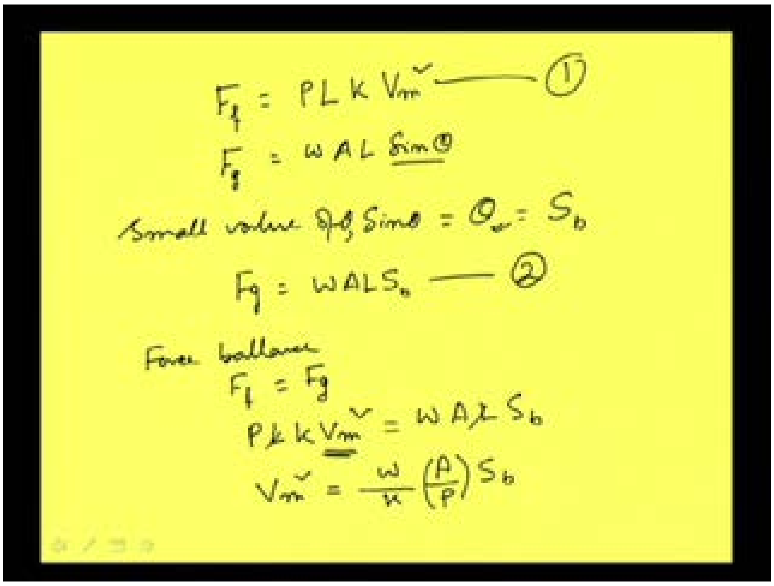

So, what we are getting that F f frictional force we, we, are getting as say P L K V m square and then the disturbing force or driving force that I am writing as F g suppose that we got as W A L sin theta. Now, for very small value of theta, for small value of theta, we know that we can express sin theta, for small value of theta, we can write sign theta can be approximated s theta. So, what is theta? This theta is nothing but the slope S. We can write it as S b; it is the slope, bed slope. So, this equation can be written now as say F g is equal to W A L into S b. So, this equation is suppose two and this equation we can write as one.

So, what we can have for the balance from the force balance, what we can have force balance, what we can have that F f is equal to F g. Now, when F f is equal to F g, we can write that P L K V m square is equal to W A L S b. Now, our interest is to find out what is P is. So, let me write it as say V m square is equal to this L and L are getting cancel, then we can write say W by K and then A by P. Intentionally I am grouping it like that a by p into say S b.

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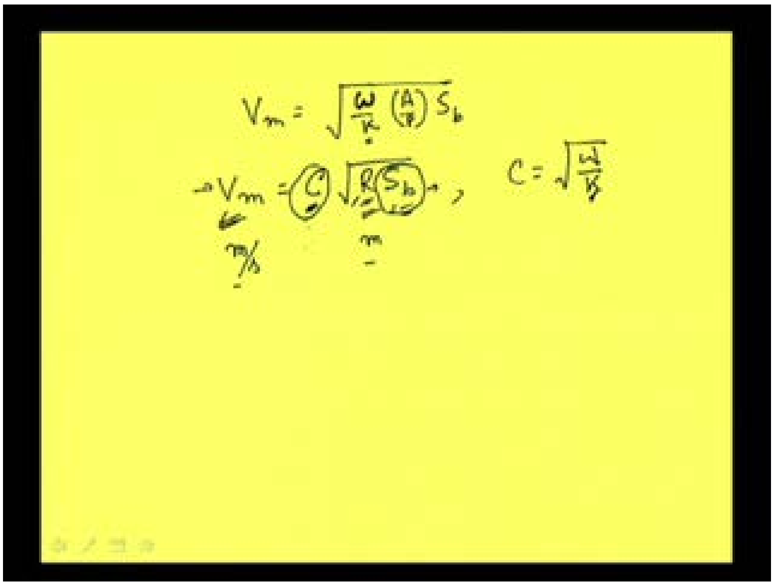

Well, from that, what we can have that V m is equal to, V m is equal to, we can write. Taking root on both side we can have root over say W by K and A by P, then say S b. Now, if we write this root over W by K, if we write this root over W by K, as equal to C because this is a, this is the unit weight of water and this K is a proportionality constant that we did use earlier. So, we can express this as a single constant and we can write that V m is equal to C, then root over A by P is nothing but R and then S b. What we are basically writing C is equal root over W by K; we are placing C as equal to W by K.

So, of course, saying so, but it is not, it is not the point that we have analytical basis. So, we can do it without experimentation it is not like that because the K value will be how much that we do not know. We know the w value of course, but the K value we do not know. So, that means this coefficient c what we are having here? We do not know the value of this C. So, we need to carry out experiment to know these values, know what will be the value of C for different roughness for different conditions well.

So, that way, this is how we can derive this value, and in this case, always we should remember that when we are talking about this sort of formula which derive empirically; that means, based on some observation whether it is laboratory observation, whether it is field observation, but these are derived on the basis of some observe value, then we are fixing. Suppose we know the R; we are observing that hydraulic radius value what is we know the S b value. Then we are observing what velocity we are finding and we have series of data of that kind, and then, with all those value, we are putting and we are finding what the value of C. Now, we are giving a numerical value of C, we are giving a numerical value of C.

And so, suppose we are suggesting that if that channel roughness is of this type, suppose it is a boundary channel, then C value is this. If it is a channel with vegetation C value is this well. If it is curved channel, it is like that. So, different way we can give this C value, but as when, when, we are putting a C value in this empirical formula a numerical value we are putting. So, this value will always depend on the value of, I mean numerical value of this velocity that we are observing numerical value of this hydraulic radius that we are observing numerical value of this S b or bed slope that we are observing.

Of course, S b is not dependent on the unit, that is, whether we consider in feet or meter, it does not matter S b is S b it is the dimensionless, but about this R and about this value velocity, it is meter per second; it is unit is in, it can be meter per square of course; it can be feet per second. So, different unit can be there similarly hydraulic radius can be meter or it can be feet different, and if we put different value of this hydraulic radius, if we put different value for this V m I mean different unit, then this coefficient value will be different.

So, when we use this sort of empirical formula with some coefficient, then always we should be careful in mentioning the unit. So, normally we do derive this things in metric unit and then the value of C we say that this is the value of C for this sort of condition, this sort of channel and in metric unit. Well, with this very basic of this Chezy's formula, then similar, similar, condition or similar approaches can be made with different assumption and some formula can be derived and let me go to some other formula that we derived by different investigator well.

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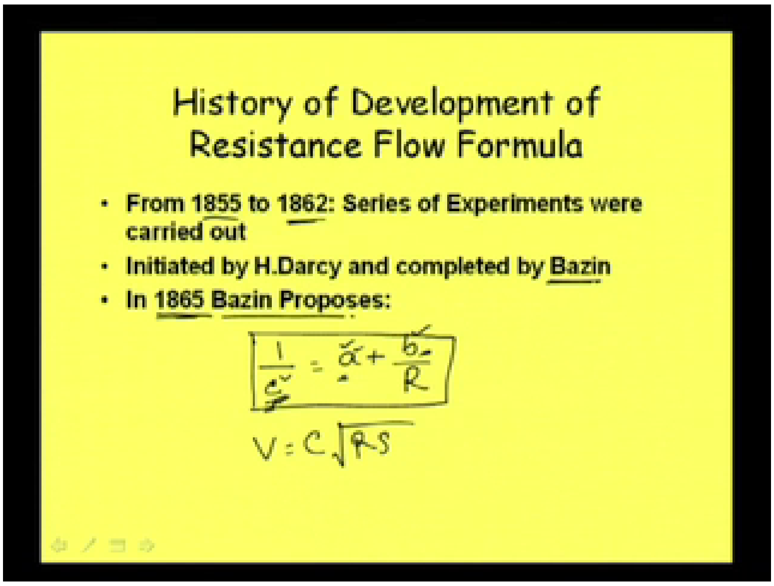

An extensive study in fact first it was started in 1769; Chezy started in 1769 long back. Now, it is 2007. So, it was started long back. Now, since then, since then, I am mean this formula was used for different engineering works, but later on then from 1855 to 1862, eighteen five, 1855 to 1862, series of experiments were carried out, series of experiments were carried out, to see that if a better formula can be developed, if a better formula can be developed, if a more say general formula can be developed.

So, that way that sort of experiments were started and it was initiated by H Darcy in, in, 1855 and then it was completed by Bazin and this sort of experiments were done and then of course completed means beyond that also people are doing and in, I am mean one from this experimental observation Bazin in 1865 he proposes one formula. So, Bazin purposes one formula.

Basically this formula he gave as 1 by C square is equal a plus b by R, well; that means what he was doing? We already know that V is equal C root over R S, C root over R S. Now, what should be the value of the C? In this regard, they did work and then they expressed this C value in terms of some other parameter a and b, and again this a and b dependence on the wall roughness, this a and b parameter dependence on the wall roughness.

So, this formula is was given and then, because say they could know about this value a and b for some of the material they could know and then they could see that C, Chezy's

C, what was given by Chezy that C can be expressed in terms of the a and b and they are more confident in using these values. So, that way this is one approach that was carried out.

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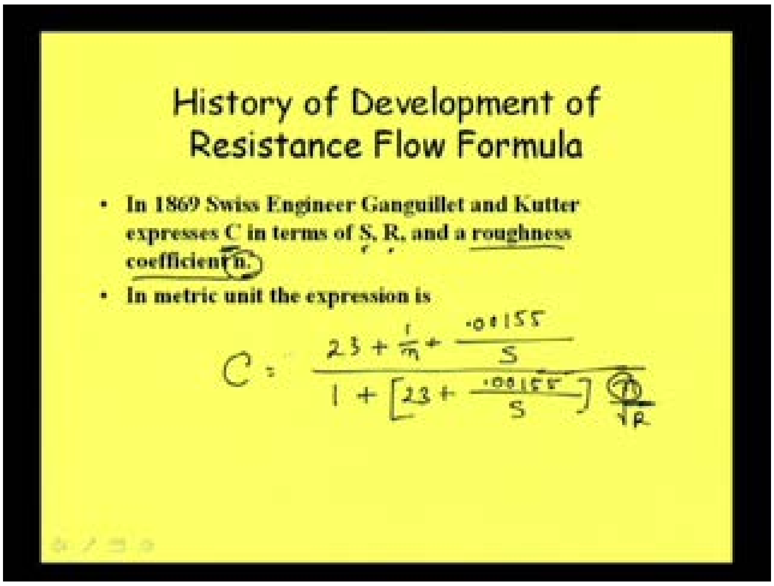

And then they work went on an in, in, 1869, knowing the history is important in 1869 Swish engineer Ganguillet and Kutter, Ganguillet and Kutter. They expresses C, they expresses C, in terms of S that is the bed slope, then in term of hydraulic radius R and they did use another roughness coefficient, they did use another roughness coefficient. They called that coefficient as n well. This is called Kutter's n.

So, in metric unit, this formula express, actually their formula is also for expressing this C value that is Chezy's C coefficient that is express as say 23 plus 1 by n plus then it was like this 0.00155 divided by S. This s is nothing but the bed slope. Then 1 plus 23 plus 0.00155 divided by S and then it was n by root over R, n by root over R. So, this formula was given by them. Here, again they did use one say empirical value that is n and this is known as Kutter's n. Well, this was, this become very much popular and it was used for channel design and many other purposes and then, but still work went on.

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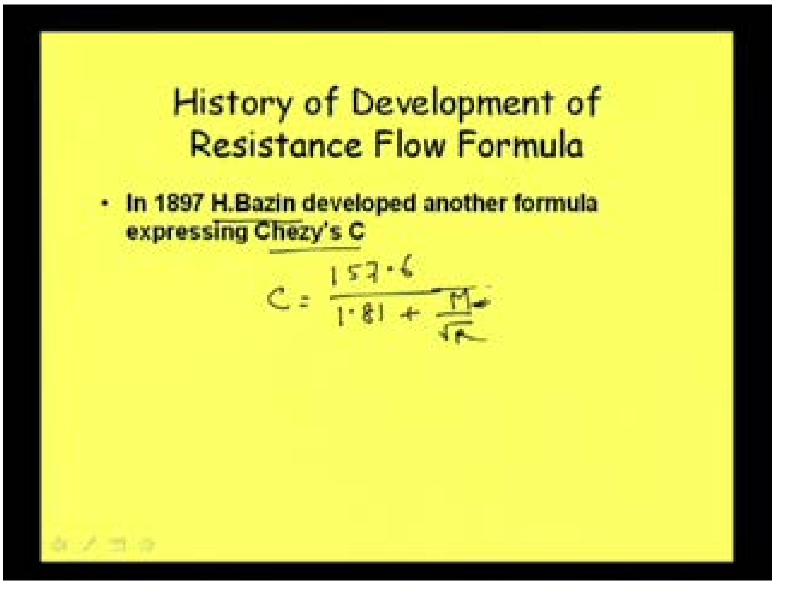

And then, in 1897, in 1897, H bazin, H bazin, he developed another formula for expressing, for expressing, the Chezy's C. So, all way basically the very basic concept, that is why we started with the analytical concept of the Chezy's formula. So, that is always remaining the same, and what people are trying that they are trying to give the expression for the value of C, so that they can get the value of C based on some of the value which is known in much better way in a particular area for because that C value dependence on lot of other factors.

So, that way people are trying, and then, this he gave this formula that C is equal to say 157.6 divided by 1.81 plus M by root over R. Again he introduced another empirical value M and this empirical value M dependence on roughness of the channel. So, coming to the same point again, this M again dependence on the roughness of the value, but this formula was not that much popular like that of Ganguillet and Kutter's formula, but still it was used in some region.

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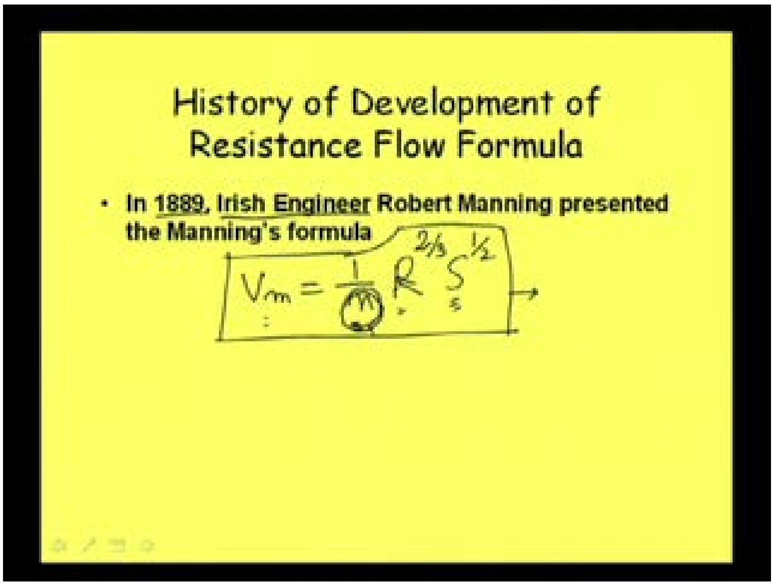

And then finally, I would like use the word finally, because since 1889, since 1889, since 1889 of course, this, this, you can see difference is not that much. Here it was given and this parallelly went on, then see once a formula is develop somewhere and to get spread all over the world and to be used, then it take some time. So, it does not mean that this formula suppose it was developed in 1897 and it was developed in 1889. So, it does not mean that this is say later formula is better it is not like that anyway.

So, this formula that Irish engineer Robert Manning's, this Manning's formula is now very very popular; it is use very widely and this Manning's formula was developed by Irish engineer in 1889 and he gave this formula as that mean velocity of flow V m is equal to 1 by n, that is, he did introduce another parameter that is the roughness coefficient, and hydraulic radius remaining the same, but the power of hydraulic radius is not half here; it is 2 by 3, that is, he did change the exponent here 1 by n R to the power 2 by 3 and S to the power half.

Exponent of S is remaining same, but the exponent of hydraulic radius is changing well, and Manning's had lot of follower, manning's had lot of follower, and this formula is becoming widely used. Now, it is also when we use this uniform flow, then we talked about manning's formula. One very basic region is that for different material, for different material, we have value for this n. Say if we just think that a wooden channel, a wooden channel; that means may be in the laboratory level or may be in some factory we have a channel where the lining is of wood.

Then if we say that, if use Chezy's formula, what will be the value of C or if you with another formula - Ganguillet and Kutter formula what will be the value of c there then it will be difficult, but if we try to use manning's formula, we have a well establish value for this roughness coefficient and even for wood. If we try to know that what will be the value of n for grass? Yes, it is there. What will be the value for n in say grass? That is also known.

So, that way for different material, series of experiments were conducted, and for different material, the value of n is available, and as the value of n is available, it is used very widely, and of course, using this formula, we can go ahead towards some other aspect of computation of open channel flow, but before going to computation of open channel flow; that means, once we know the hydraulic radius and once we know the slope, we can compute what is the velocity, and then, we can do some other computation, but before that, we need to know although they n value as I have just told in a simple way that it is available for different material, but again in the same material, in the same material, depending on different condition, depending on different condition, this n value may be different, this n value may be different.

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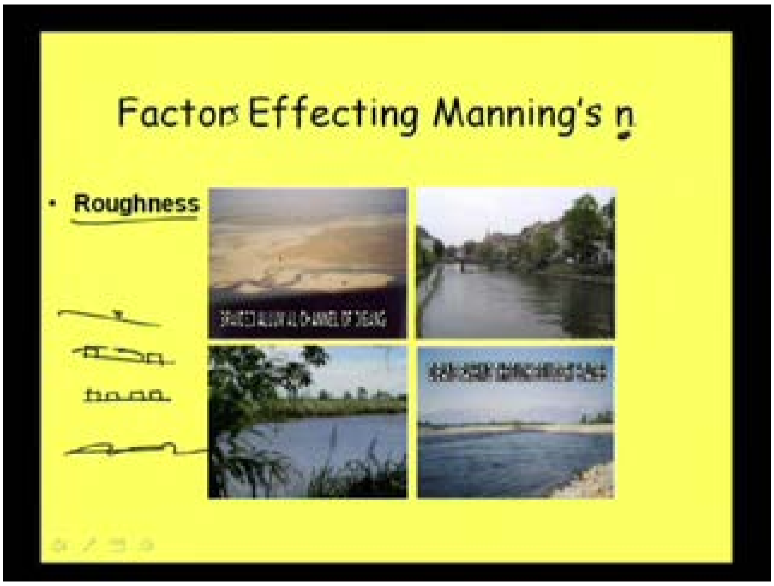

Well, to just have a look into this thing, that is, we need to discuss this point, that is, factor effecting manning's n. What are the factors that affect the manning's roughness coefficient and this is called Manning's roughness coefficient. First is definitely the name itself it is said that roughness. Roughness is the first, and if you just see, if you just concentrate in the slide, you can see that this channel here we have alluvial soil, and so, resistance will be of different type.

Here we have vegetation on the side; here we are not talking about vegetation inside the water, but on the side, we have vegetation. Here we have say boulder, bouldery bed and side and here we have the lining here; here we have concrete lining. So, depending on the roughness of the side and the bed, the manning's n will be different. More the roughness, definitely more will be the resistance well, and then, suppose here if I draw in a channel say roughness not only means this things.

So, this is roughness and that is roughness. Now, this gap between this, suppose that height is same and here say this is the same height roughness, but closely pack, closely pack. So, here, as the gap is more, the flow will be having the different way. Say this is going like this and then total flow is this one. Then close separation will be there and it is again coming like that, but here, it will be of different type well. Now, so depending on this spacing of the roughness, the channel may be like this in reality and channel may be like this, channel roughens, bed roughness, and depending on the characteristic of bed roughness, the manning's formula n or the value of the manning's roughness coefficient n will be different.

So, lots of things are there which we and need to study regarding the roughness of the bed, and say in fact some other facts are also there when we talk about two-dimensional flow, when we talk about two-dimensional flow, in a bed the roughness in, roughness value in one direction and in other direction; in reality may be different. The flow if it is component is moving in the other direction and roughness characteristic may be different in that direction, but so, that sort of complexities are there and definitely the some work has been done in that line.

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And then factor effecting manning's n. The second factor what you want to say is the vegetation. Well here by vegetation, we are not meaning that what sort of vegetation are there on the side. What we are meaning that normally in our drainage or in the natural river also we can have vegetation in the bed of the channel under water vegetation can be there, and of course, sometimes in, in, Indian condition particularly we find that in the drainage, we have vegetation growing and then flow is moving through, I mean through the vegetation, and then, this, the characteristic of this vegetation as what is the…

Here, I am showing one slide, that is, showing under water vegetation, it is a photograph from one river in the upper Assam area. It is called Subansiri river, and there you can see the vegetation is there and this vegetation the flow is in this direction, flow is in this direction, and vegetation is also incline; that means, with the flow, because of the flow velocity, the vegetation is incline in that direction.

Now, when the flow is moving, the vegetation is just incline in that direction; that means the some energy has been consume in moving the vegetation also. May be vegetation is not getting remove from this part, but the top of the vegetation is incline in this direction. So, some energy has been consume. Say originally a without the flow vegetation may be like this. Now, when the flow is coming, vegetation is moving like this. So, some energy is being consume there, well.

So, what is the height of this vegetation, what is the height of this vegetation? This sort of experimental study has also been carried out that how the height of the vegetation influences the manning's n. Now, height of the vegetation and flexibility of the vegetation. If your vegetation is like that when the flow is moving, it cannot be bend or it require more energy to get bend. So, like that depending on height of vegetation and the flexibility of the vegetation, this resistance formula in, in, the resistance formula this roughness parameter n will be different. So, this is one factor that affect the roughness, that affect the value of the manning's roughness coefficient.

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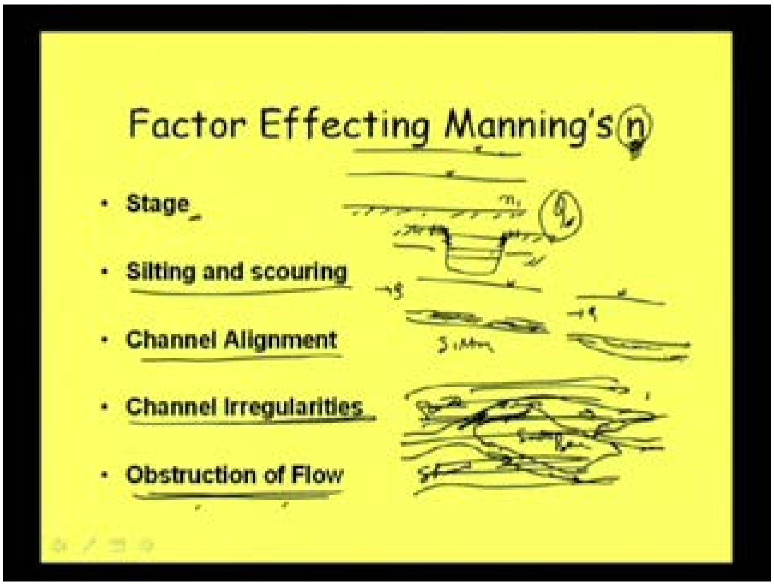

Then some of the parameters other parameters that I am putting here we can concentrate in the slide that is the stage. The stage, stage means basically depth of flow, stage means depth of flow. In the same channel, in the same channel, if the depth of flow is this much, then suppose we are having some value of roughness coefficient n, and the same channel if the depth increase, if the depth increase to this height, then the roughness value that is the n value for this. One suppose if I say n 1. I am not talking about please just be cleared that I am not talking about total resistance force. Resistance force will definitely be different because it is a small depth and your surface area in contact is less.

So, that way to total resistance force will definitely with different from this depth to that different depth, but I am not talking about the total resistance force. What I am talking about is that the value of the resistance parameter and itself it changing with the depth.

Higher the depth, higher the depth, lower is the value of a smaller is the value of the n. In a channel that means what we can understand? What is the physical significant of that?

Suppose in a river, in a river, we have observed, we have observed, the flow and then we have seen we have measured the even velocity, and for the given bed condition, bed material and side material, we have found that this can be the roughness coefficient n, and that way say we have seen that, if a discharge Q is coming, if a discharge Q is coming, then for that discharge Q using that roughness coefficient n we can calculate what will be the velocity of flow.

Now, once we can calculate the velocity of flow, we can also calculate what will be the depth of flow. Of course, these are interdependent that I will be coming when we will go for computation of open channel flow, but the physical significance we need to know, that is, given discharge, given n value, we can find a depth of flow. Now, suppose using that depth of, using that n value, we are considering the high discharge is coming and for that high discharge flood is coming. So, that, for that flood what will be the depth we want to know.

So, for that high discharge, we are using this n value which we have observed may be in the lean period or may be, because say observing this flow, measuring this flow in the high flood period is not possible, that will be very risky. So, what we do normally in the lean period or in the moderate period, we go from measurement of these things and then we can have some idea about the n value.

Well, now, in high flood period, suppose we are, yes, we know that from the hydrology or from statistics analogy of the analysis of the hydrological data, we got the maximum discharge of this much can come, and for this discharge, we want to know what will be depth of flow because we are interested in the point that whether there will be a flooding or not for that discharge. Now, say we have computed the discharge using the Manning's formula. We are getting a higher depth fine, but the n value what we are using or what we are using may not be actually the n value for that particular depth.

So, when a high discharge is coming, depth is increasing. So, n value will reduce, and when n value reduces, the things will change. So, that way, I mean knowing this particular aspect, that is, how the n value get change with the depth is significant, and of course, sometimes some interesting phenomenon occur. We were carrying out one experimental study on open channel flow and that was done in a field channel, that was done in a field channel, and, but what we could observe that, when the depth is increasing, well you can concentrating the slide, that is when depth is increasing, we could find that here our depth is this much and then we measured the velocity; we measured the depth and we could compute what is the n value. It was and this is the we made a field channel like this.

And then, we could see that up to certain distance, yes, it was following what is being stated, that is, with the increase of depth, the n value is decreasing, but when it was coming up to this much, then we will be finding that well n value is increasing with the increase of depth, n value was increasing. So, we got confuse why it has happen. Then the very basic reason was that there were some grass and some vegetation here and roots of this vegetation were expose to the side, root of this vegetation were expose to the side.

And when we are cutting these things up to a certain depth, these roots of this vegetation are there. So, when depth is increasing, once it is reaching this particular depth, when it is coming in contact with the roots of the vegetation, its roughness is increasing and that way we got the total roughness, because when get a roughness value, this is basically we are talking about the average roughness. So, that roughness coefficient is was increasing. So, that sort of some phenomenon can be there, and when we are using this n value, we should be aware of all those different consequence.

Then let me talk about another factor that influences the roughness coefficient. This is silting and scouring, this is silting and scouring. Well, in our earlier class, we did discuss about silting and scouring in a channel, in a channel, say due to because of this flow, there can be sometimes deposition and silting, that is, the bed is sediment carried with the discharge get deposited and that we called as a silting.

So, this is silting, and then, again in some cases, again in some cases, suppose we are having some discharge, and because of this discharge, this is getting scoured and this channel depth is increasing like that. So, this Manning’s Roughness coefficient decreases due to silting, manning’s roughness coefficient decreases due to silting. When there is a silting, manning’s roughness coefficient decreases, and when there is a scouring, manning’s roughness coefficient increases.

So, when we talk about a channel whose bed is not line, then we should be careful in using the manning's n because this sort of, when it is a silting case, then it will be changing like that; when it is a scouring case, it will be different and. So, only on the basis of material we cannot say.

Then again another factor is channel alignment, again another factor is channel alignment. Well, now the channel will not be always say straight, channel can be straight as well as channel can be curved. So, now, say given the other condition same, suppose the bed material or side material are same and depth is also suppose same. Now, given the other condition same, whether our manning's roughness value n will be same here and here.

So, more the curvature, that we will find that more the curvature when your curvature is increasing, your n value is increasing; more the curvature, more is the n value. So, if we conduct some experiment in a straight channel, if we conduct some experiment in a straight channel and we are getting some value of the manning's roughness coefficient n and then we are very much sure about the bed material and we are very much sure about the depth what it can be done.

In the practical field, we are planning to apply this formula with this particular value of manning's what we have computed in the lab. Then in the real field if we see, that that channel is maintaining other things, but the curvature is there, and if this is a mild curvature, then is fine, but if the curvature is quite significant and we cannot ignore that, then we need to increase the n value by some amount of course. What we mean by some amount that definitely I cannot give a numerical value, that will dependent on experience. Of course, some standard value are there if curvature is increasing like that, then we can increase the n value by some percentage.

So, this is there, and experiment can also be conducted. In fact, in this aspect, experiment can also be conducted and can be observed in the field also to get the change in the n value. Then another point that we are talking about is the obstruction of flow, obstruction of flow. So, all other things remaining the same in a channel if we have a bridge, suppose in a channel we have a bridge here, now when we have a bridge, there will be some piers in between. That is what there can be different type of obstruction in the flow.

Now, if there are some obstruction in the channel, will the n value remain the same? Definitely not that with obstruction, with obstruction, the n value will be changing, well. Now, here, it is not possible to generalize the thing because obstruction may be of different type, and depending on the type of obstruction, the n value will be changing accordingly. So, just we need to know at this level, that Manning's n get effected by the obstruction that is there in the flow.

Then there is another point that type, that is, say irregularity of the flow, flow irregularity, that we can say flow irregularity, or we can call rather it is not flow irregularity; it is better to say as channel irregularity; it is a channel irregularity. Yes, it is written here. I did skip this point while it was explained here. Well, channel irregularities.

So, in a channel, as we could see earlier also, there can be sometimes some ups and down in the, there can be some hump like this. Say there can be some hump like this. In a channel, the bed will not be like that rather say it is going this way. There is some hump like that rising of things and there can be some deeper portion, and in the braided channel, earlier we were showing that there are lot of branch channel it is going and in between some sandbars are there. Now, say when this sort of channel flow in full condition, when this sort of channel flow in full condition, then apparently you do not see this roughness and irregularities in a very clear way, but in dry situation, you can see this irregularity that are existing in the channel well, but this irregularities will influence the value of roughness parameter n.

Well, so, now say in a braided channel, in a braided channel, for a braided channel means if I draw a plan view of the braided channel, say it is a wide channel streams are coming like this and it is going this way. Some streams are going in this way like that, and then, it is another stream going this way and then this way. So, like that these are say flow direction, these are flow direction, and these are some sandbar, sandbar we have. Well, these are again sandbar, sandbars. So, like that it is flowing.

Now, say for this particular small channel, we can see what is the bed roughness and what is the bed material, and that way, we can find out what the n value is. For this channel also we can find out, but when this channel will be flow with high discharge, then all these things will get submerge and the flow may be completely moving covering these undulations of the bed and this sort of channel irregularities will influence the n value.

So, what n value we got for this small channel or this small channel will not be applicable when the channel is moving with a very high discharges covering all these irregularities. So, those irregularities will definitely influence the n value, and because of that, we need to take care when we compute uniform flow, when we do calculation of uniform flow, to know the depth of flow indirectly from the discharge, then we should be aware of all these parameters, I mean some of the parameters already I have discussed beforehand like vegetation and roughness, well. This is one figure of braided channel that I have explained right now. So, all these point we need to take care, well.

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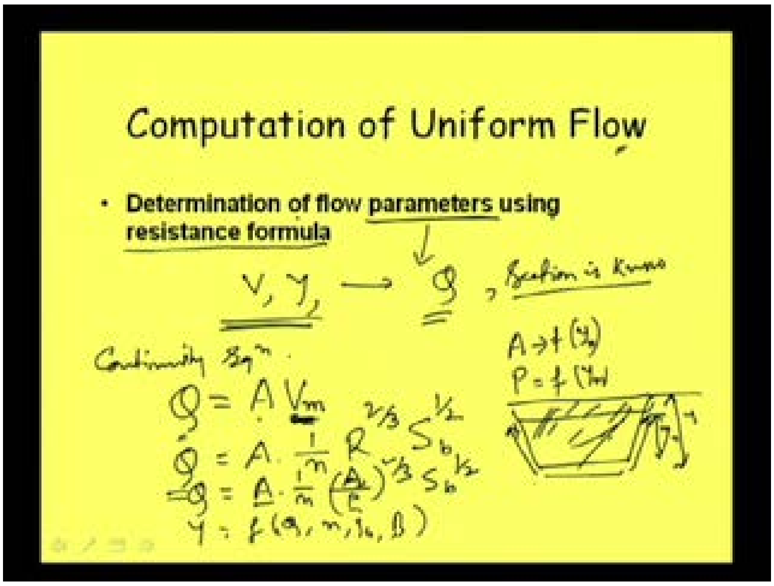

And then, taking consideration, taking into consideration all these different factors, we need to go for computation of uniform flow, well. Now, what we mean by computation of uniform flow? Definitely now we have with us one formula. Well several, a series formula we have, and out of that, at least one formula we have Manning’s formula which is very popularly use for which formula, the n value is known for different material and also we know that these value of n get effected by different conditions, different factors influence this n and how it is effect.

So, that we also know, and knowing all these things, say let us assume that we know the n value, we know the n value, for the required material. Then discharge is say given, and then, we need to know what will be and, and, the sectional size, this is the bed width top width all these things are know. Then our problem in hand is to know what will be the depth of flow.

So, by computation of uniform flow, we mean determination of flow parameters using resistance formula, determination of flow parameters using resistance formula. So, that determination of flow parameters means again there can be different flow parameters that we can determine. Say for example, of course, the resistance formula is giving us velocity V, and when we talk about computation of uniform flow, we mean that computation of V, computation of Y, these are the resistance flow formula and when our discharge is known. Say Q is known and our sectional area is known. Section is known not only sectional area. Section is known, section is known.

So, for a known section, for a known section, for a given discharge, the problem of computing these unknown parameters we called as computation of uniform flow. So, depth velocity all these we can compute. Well, for that, we will be using the very basic equation. Already you have discussed in detail what is conservation of mass, what is conservation of momentum, what is conservation of energy, and that conservation of mass lead to the continuity equation and that, that, very continuity equation, and in case of open channel flow hydraulics, we assume that the, we considered that fluid is incompressible, fluid is incompressible, that is, row is not changing, row is not changing, and because of that, when we talk about conservation of mass. So, when row is constant.

So, mass is nothing, but row into volume. So, we can call conservation of volume also and we deal this as conservation of volume, and conservation of volume means we talked about per unit, the volume flowing per unit time say Q and that Q is equal to area into velocity. So, this is our very basic continuity equation. So, we start from that, we start from that when we talk about computation of uniform flow.

So, continuity equation that is given as Q is equal area into velocity. Now, this velocity we are talking about the mean velocity. So, we are writing as area is equal to, sorry, Q is equal to area into V m, well. Now, this V m, for obtaining this value of V m, we can write it from the manning's formula. So, how we can write that Q is equal to area into the Manning's formula we can write here 1 by n R to the power 2 by 3 then S to the power half S b, because of uniform formula, we are writing this as S b; S b to the power of half, well.

So, A 1 by n R to the power 2 by 3 S b to the power half. Now, here, if we just rewrite it in this from that A into 1 by n, then R is nothing but again area divided by perimeter to the power 2 by 3 and S b to the power half well. Now, discharge is known; area is unknown; perimeter is unknown. In fact, now we have expressed this velocity in terms of the geometric parameters of the section that is the area and perimeter, cross sectional area and perimeter. So, this area is again it is a function of Y which is unknown or as we are talking about uniform flow, so it is a function of Y n.

Then perimeter is also a function of Y n. If I take a trapezoidal channel, if my depth is this much, let our depth is Y n, then our sectional area is this much; our perimeter is this much. This is our perimeter, but if my Y n changes, say this Y n, then our sectional area changes and perimeter also changes well. So, that way this area and perimeter are function of Y, and here also that means this is also a function Y, this is also a function Y, this is also a functions of Y.

Now, if from this expression, if it become possible that Y we can separate out. Suppose this Y n if we can separate it out, then it will be possible to compute directly that Y is equal to, Y is equal to, in terms of Q n n and S b and some other say some other value like bed width, top width and all, but if we cannot separate out this Y, if we cannot separate out this Y, then we may not be able to, it may not be possible to compute this Y value directly. So, here is the problem of computing open channel flow.

Well, we have seen some of the very fundamentals regarding the uniform flow formula and how this formula is used for computing open channel flow, but the challenge is or the problem over coming this, we need to see and that we will be doing in the next class. So, thank you very much for attending this class and we will be going for the computation of open channel flow in the next class. We have different methods; we have different formulas and we will see how we can do that. Thank you very much.