Flow Resistance Equations

SPEAKER Charles Berenbrock: Roughness coefficients can also be determined from equations. A number of investigators have developed equations for a particular type of extreme condition. Usually these equations are based on stable channel conditions. These equations indicate that roughness is primarily a function of the bad material size and hydraulic radius. For example, Strickler's equations was developed for gravel-bed streams in Switzerland and it's given by the equation of n is equal to 0.034 times d_{50} to the 1/6th power. Note that d_{50} is in feet. A lot of times you measure your particle sizes or your gravel sizes in millimeters. You have to convert that to feet.

The lower equation is Jarrett's equation, and he developed it for mountain streams in Colorado. Jarrett's equations is n is equal to 0.39 times the slope to the 0.38th power times "R" to the minus 0.16th power. Remember that R is your hydraulic radius. It is area divided by your perimeter and R is in units of feet and then S, your slope is in feet per feet.

Bed forms can also affect the roughness and usually in sand-bed channels, we get different bed forms. While we normally think of velocity as a function of bed roughness, for mobile bed streams, the bed roughness is variable and is a function of the flow velocity. Simons and Richard classified flow into three regimes and this is for alluvial channels. The lower regime flow or the lower flow regime, I should say, represents ripples and dunes and then you have a transitional flow regime and it represents washout dune and plain bed. And then you have an upper flow regime. You have plain beds, anti-dunes and dunes and shoot in this regime. In the former regime, it usually represents a Froude number from 0 to about 0.7 where as the transitional flow regime represents a Froude number of 0.7 to 1. And then the upper flow regime is greater than 1, a Froude number greater than 1. And you can see this graph here, we have the different types of regimes of flow here or I should say the different bed forms here and then we had the assigned Manning's n to them. A note that the Manning's n are generally pretty low. The highest Manning's n in all these pictures here is when you have dunes and it can go up to 0.040.

In the lower flow regime, resistance to flow can be quite large and then in the upper flow regime, the resistance to flow is usually small. Resistance to flow has two components. It has the skin

friction. We call it skin force, and also the form drag. As you saw in this lesson, we can estimate Manning's n or the roughness coefficient by different methods. I suggest that you get together with colleagues and try to measure them together or determine them, I should say, together and then discuss why you have differences if you do and or similarities so you can get the best estimate of your roughness coefficient. This concludes Lesson 12.