Flow in Channel Sections

SPEAKER Charles Berenbrock: In this section, we'll be looking at flows and discharges in channel sections and the channel might be composed of several distinct subsections with each subsection having a different roughness value. For example, a situation like this might be flood flows where you have flow in an overbank channel, let's say the right side of the floodplain, and then you have flow in your main channel and then you have also maybe flow in the left side of the channel. We know that in overbank channels or the floodplains, they're usually rougher than it is in the main channel. If we use Manning's equation to solve, let's say for discharge, for this cross-section we might be overestimating or underestimating what the true discharge would be and the reason why is that the friction loss that we have in Manning's n or in Manning's equation, we assume that it is uniformly distributed across the whole entire cross-section. So then how should discharged be calculated for such a situation? Well, let's go through an example here to solve that problem.

The example problem we're gonna be looking at here is a channel and then also it has a right floodplain only. The main channel is about 50 feet wide, 10 feet deep and the Manning's n for the main channel is, we can say, 0.030. And then the floodplain or the right plain cross-section is 150 feet wide, the water depth is 2 feet and the Manning's n that was determined for this floodplain section is 0.050. Well, usually what we do is we use Manning's n equation to solve this problem. And Manning's equation, remember from your previous lessons is Q is equal to 1.49 divided by n, the Manning's roughness value, times A, the area, times a hydraulic radius to the 2/3 power, times a friction slope to the 1/2 power. Remember, hydraulic radius is the area divided by the perimeter. Because conveyance is directly proportional to the discharge, in this example here, we're gonna be computing only the conveyance. And we're gonna compute the conveyance by three different methods. What we're gonna do here is determine conveyance using an average cross-sectional n value, and then also using an effective cross-sectional n value, and then also by subsectioning the cross-section and sometimes we call that a composite cross-section. If we go on to the next slide, you'll notice by doing this, for this channel, we have different conveyance values. By using the average Manning's n value for the entire cross section, the n value would be 0.040 because we average the n value from the main section and the floodplain section to get

0.040. And if you look at the conveyance, it is 70,279. If you look at the effective method, it produced an n value of 0.026 and that 0.026 is, of course, lower than the real values that we have here. Those are really--using the effective value really is probably the wrong way of doing it, trying to do it that way. It's a waiting method but it gave a K or a conveyance of 74,945.

Now, if we subsection the cross-section, in other words, we determine a K for each of the cross-sections and do it that way, we get a conveyance of 107,969. And there we are using the actual true n values for each of the sections. And so thus--because it gives a truer value, we wanna be using the subsectional method. If you notice there that the two methods, the average and the effective method gave differences that were like 30% lower than what the subsectioning method gives. Also note that the subsectioning method adjust for the non-uniform distribution of boundary resistance along the cross-section. By that, I mean that we're adjusting the n value that is representative in each cross-section.

So in conclusion here, to correctly adjust for the non-uniform distribution of roughness along a cross-section, the Manning's equation or specifically conveyance is computed for each subsection and then they are summed together to compute the total conveyance of the cross-section and then the rest of Manning's equation is used to derive what the flow is in that cross-section. This concludes this section.