Flume Demo Culverts

**SPEAKER Rick Huizinga:** Welcome to the Flume Demonstration for Lesson 17. In this flume demonstration, we’re going to try to create for you several of the various types of culvert flow that you will see out in the field. And, of course, in the lecture we showed you that there are six types of culvert flow. We’re going to show you the first four types. And what we have right here is a type 1 culvert. The thing that characterizes a type 1 culvert is the fact that the culvert is at a fairly steep tilt. It is greater than critical--super critical flow. And as a result of that, critical flow occurs right here at the inlet. Now, you can see that the water surface elevation upstream of the culvert actually flows to the upstream of road embankment just like that. But through the culvert opening, it goes through critical. In this particular type of flow, we would compute then--we would need to obtain the water surface elevation upstream of the culvert some distance and we would want the water surface right at the inlet as well because this is critical and this is critical depth. And the flow equation then would take into consideration the friction losses between the approach and the inlet to the pipe and that is how the discharge would be computed for a type 1 flow.

For type 2 culvert flow, the culvert sits much more flat and so it’s on a mild slope or a sub-critical slope, therefore pipe flow in the pipe is at normal depth but it goes through critical at the downstream end. So, our energy equation then is written between the upstream approach and critical depth at the outlet. We have to take into consideration the friction losses between the approach and the inlet to the pipe. We have to take into account the entrance losses in the pipe and we have to take into account the friction losses through the pipe. And these are all accounted for in the n value and the C value in the type 2 flow equation.

Type 3 flow is when the tailwater depth is such that the outlet is no longer at critical depth but we have tranquil flow throughout the culvert and you can see that situation here. In this situation, the computations run between the approach section and again right at the outlet, but at this point the outlet is not flowing at critical. So we have to take into account here—we have to take into account the friction loss between the approach and the inlet.
Flume Demo Culverts

We have to take into account the inlet losses and the friction losses through the pipe, and these are accounted for, again, as an $n$ value and a coefficient $C$ that account for these losses in the type 3 flow equation.

Now type 4 flow, as we were discussing in the lecture, is a very unique case. In type 4 flow, the outlet is submerged. So anytime out in the field when you see a submerged culvert outlet, you know that it is type 4 flow. Neither types 1 through 3 or types 5 nor 6 have the submerged outlet. It is unique to type 4. So in this computation, the energy equation goes between a point at the approach and a point beyond the outlet because, once again, the outlet is not flowing at critical so it’s not a control point anymore. The equation takes into account the friction loss in the approach, the entrance losses, the exit losses in the pipe, and the losses through the pipe. Many times the water surface elevations in the field are obtained on the upstream and downstream faces of the road embankment away from the culvert so that you get away from the drawdown effects at the culvert itself.

And these are basically the first four types of culvert flow. We’re not going to try to create type 5 and type 6 because they’re difficult to create in the flume, but this at least gives you an idea of what some of these types of culvert flow look like so that you know what sort of characteristics to look for out in the field.