Part 650 – Engineering Field Handbook

Subpart E. Structures

IA650.40 Types of Inlets for Principal Spillway Pipes

Many conservation practices, such as ponds, some grade stabilization structures, some wetland structures, some water and sediment control basins, etc., require the use of a principal spillway pipe. The most common materials these pipes are manufactured from include corrugated metal, aluminized corrugated metal, smooth steel, PVC, and concrete. Some factors which go into the decision as to which material to use include pH of the backfill material, soil resistivity, texture of the backfill material, availability, ease and method of installation, and cost.

Regardless of the kind of material used to fabricate the pipe, there are three primary types of inlets that are used. These are hood inlets, canopy inlets, and drop inlets. These inlets are used to improve the hydraulic efficiency of the principal spillway when compared to a pipe with no fabricated inlet. Each of these types of inlets will be discussed in this Amendment.

When the water level in a pool begins to rise above the crest of the principal spillway, the initial type of flow in the pipe is weir flow. As the water level rises, it goes through a period of orifice, or slug, flow before the pipe is primed and goes into full pipe flow. Full pipe flow is also called pressure flow.

The pond standard states that "When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the (auxiliary spillway) inlet shall be such that full flow will be generated in the conduit before there is discharge through the auxiliary spillway." This requirement is to make sure the amount of time the pipe is in orifice flow is minimized as orifice flow can cause vibrations in the pipe which could lead to failure of the principal spillway. Hood inlets, canopy inlets, and drop inlets all serve the purpose of reducing the amount of time the conduit has orifice flow.

IA650.41 Hydraulics of Hood Inlets, Canopy Inlets, and Pipe Drop Inlets

Three of the primary tools used to compute pipe hydraulics are:

1. Iowa Engineering Spreadsheets
2. Engineering Field Tools (EFT) – Utilities Tab - Formulas
3. WinPond Computer Program

These tools provide the designer with easy methods to compute flows for various pipe types and configurations. The models used to develop these programs are similar but not identical. However, the end results of the routings using these tools are generally the same, but may have a slight variation in the final routed elevations.

The Iowa Engineering Spreadsheets and the Formulas utility program in EFT have very good descriptions of the formulas that are used to compute the elevation – discharge tables. Following is a brief summary of each of these tools.

1. IaHoodInlet.xls Spreadsheet
   From the Iowa Engineering web page, click on Engineering Spreadsheets. Open the IaHoodInlet.xls spreadsheet. The page titled "Weir and Slug" shows the inputs for developing the weir and slug flow hydrographs. To get a detailed description of the program, go to the "Info" tab and double click on the square that says "Acrobat Document." This document discusses the basis for the design of the spreadsheet, provides instructions for how to use the spreadsheet, defines basic input parameters, and shows the flow equations and tables that are utilized to compute flows. The formulas are shown with the variables defined.

2. EFT – Utilities – Formulas
   From the "Formulas" tab, click on "Hooded Inlet" under "Structures." The program opens to a screen with a cross section view of a conduit with a hood inlet through an embankment. This screen has the boxes for the program inputs. To get a discussion of how the flow through the conduit is computed, click on the "Help" box in the lower left corner of the screen. This shows the weir flow, slug flow, and full pipe flow equations with definitions of the variables.

3. IaDropInlet.xls Spreadsheet
   From the Iowa Engineering web page, click on Engineering Spreadsheets. Open the IaDropInlet.xls spreadsheet. This spreadsheet determines the flow by analyzing weir flow over the inlet, inlet orifice flow, barrel orifice flow, and full pipe flow. The "CFS chart" tab shows a typical pipe capacity graph with the four types of flow shown. To get a detailed description of the program, go to the "Info" tab and double click on the square that says "Acrobat Document." This document describes when this program may be used, the basis for developing the program, definitions of variables used, and the flow equations used to evaluate the four flow conditions.

4. EFT – Utilities – Formulas
   From the "Formulas" tab, click on "Pipe Drop Structure" under "Structures." The program opens to a screen showing a cross section of a conduit and drop inlet through an embankment. This screen has boxes for the program inputs. To get a discussion of how the flow is computed, click on the "Help" box in the lower left corner of the screen. This shows the weir flow, orifice flow, and full pipe flow equations along with definitions of the variables used in the formulas. It also includes drawings that show the typical water levels in a conduit with a drop inlet under the four flow conditions and how the hydraulic head is measured for each type of flow.

Currently, neither the IaHoodInlet.xls spreadsheet nor the EFT – Formulas have separate routines or programs for canopy inlets. However, these hood inlet tools may be used to compute flow through a canopy inlet. Research has shown that canopy inlets have a slight hydraulic advantage over hood inlets. Using these hood inlet tools for designing canopy inlets will generally give results that are slightly conservative. The WinPond program allows for using several different types of inlets. The algorithms used in WinPond for pipe hydraulics use different coefficients for hood inlet versus canopy inlets; therefore, the routed results show the slightly improved hydraulic efficiency of the canopy inlet over the hood inlet.

IA650.42 Details and Dimensions of Hood Inlets, Canopy Inlets, and Pipe Drop Inlets

Iowa Standard Drawings IA-1210, "Details of Hood Inlet for Annular or Spiral C.M. Pipe -- 6 – 15 Inch Diam.," and IA-1211, "Details of Hood Inlet for Annular or Spiral C.M. Pipe -- 18 – 48 Inch Diam.," provide the details needed for designing, dimensioning, and fabricating hood inlets.

Iowa Standard Drawings IA-1213, "Metal Pipe Canopy Inlet," and IA-1214, "Plastic Pipe Canopy Inlet," provide the details needed for designing, dimensioning, and fabricating canopy inlets.

Iowa Standard Drawing IA-1131, "Details of Corrugated Metal Pipe Vertical Inlet with Anti-Vortex Device" provides the details needed for designing, dimensioning, and fabricating drop inlets.

These Iowa Standard Drawings are located on the Iowa Engineering web page under "CADD Drawings."

IA650.43 Dimensions Required for the Anti-Vortex Device for Drop Inlets

When a pipe drop inlet is used, an anti-vortex device or baffle wall is required to minimize the amount of air that is pulled into the conduit. Air in the conduit can result in slug flow causing the system to be unstable. It also reduces the hydraulic efficiency of the inlet. The following table provides dimensions for anti-vortex plates for inlet pipes of various diameters.

Figure 650-E1: Drop Inlet Anti-Vortex Dimensions

Drop Inlet Anti-Vortex Dimensions

Riser Diameter - Inches	Anti-Vortex Device		
	Length - ft.	Height - ft.	Gage
18	5	2	16
24	6	2	16
30	7	2	16
36	8	2	14
42	9	2.5	14
48	10	3	12
54	11	3.5	12
60	12	4	10