Stabilizing Pipes in the Flocculation Tank

Kelly Huang

April 29, 2013

Problem Definition

In the current AguaClara plant design, the baffles in the flocculation tank are held up by long pipes that span the length of the channel. As flow rate increases, the baffles are spaced further apart, as seen in Figure 1.

Currently, the ends of the pipes are not connected to anything and have no end support. This could cause deflection in the pipes and lead to instability of the system. My task is to code for a design detail that stabilizes the pipes by connecting the three pipes in each column together at the ends.

Design Details

In each channel, the pipes that brace the module against the wall should have the ends connected for stability. Each column consists of three pipes and the three pipes will be connected to each other at the ends. The top pipe will have an elbow pointing down, the middle pipe will have a tee elbow, and the bottom pipe will have an elbow pointing up; then the elbow-tee-elbow configuration will be connected by two vertical pipes (Figure 2). This will increase the stability of the pipes and prevent deflection, which is especially important at higher flow rates when these pipes are even longer.

The AC flocculator code splits and draws each flocculation tank in two sections: "Last Channel" and "Beginning Channels." In the last channel, there is one less baffle at the end to account for the exit orifice. All other channels have identical numbers of baffles and are coded in "Beginning Channels." In both cases, "modules" are used as the building blocks in assembling a channel of baffles. A module consists of an even number of baffles connected by pipes and caps. To create a channel, the modules are arrayed across within a channel and connected by shorter pipes (Figure 3). More information regarding the connections of the pipes can be found in Laurence Zong-Shi Lin's Flocculator Final Report from Spring 2011.

While the "Last Channel" section draws only one channel , the "Beginning Channels" section may code for more than one channel depending on the plant

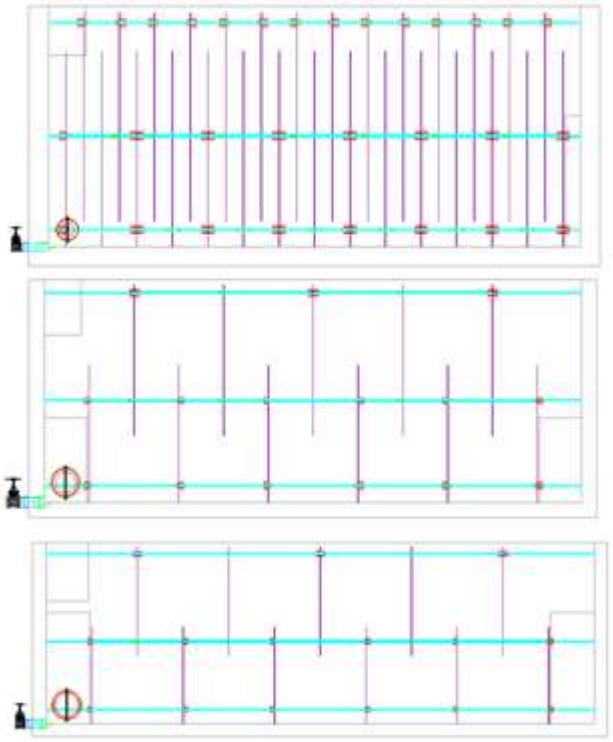

Figure 1: Sideviews of 6Lps, 25Lps, and 50Lps Flocculation Tanks

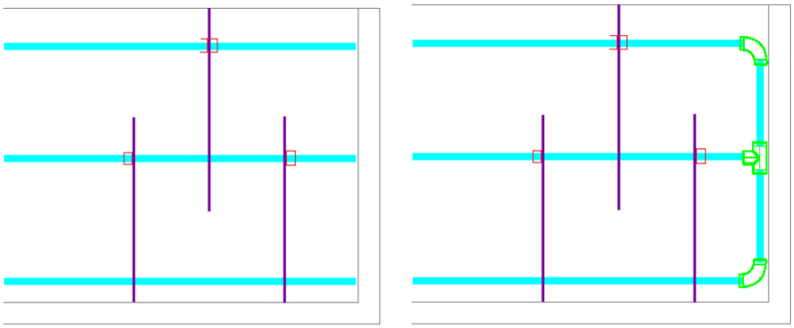

Figure 2: End of Channel Without and With Proposed Support

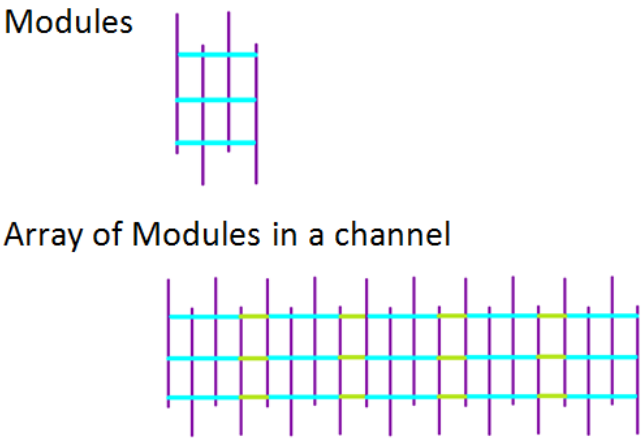

Figure 3: Sideview of Modules in a Channel

flow rate. In cases where "Beginning Channels" consists of more than one channel, the first channel is mirrored and arrayed across to the other channels.

The code that draws the elbows, tees, and pipes needs to be implemented in both sections so that the ends of all pipes in the flocculation tank are connected and stabilized. To maximize efficiency, in "Beginning Channels" my code will be placed after a channel is drawn, but before it is arrayed to another channel.

Another consideration is the two different cases of baffle support: Overlapping and Non-Overlapping. In the Overlapping case, the baffles are close together and all three pipes run through every baffle. In the Non-Overlapping case, the baffles are further apart and the pipes are staggered so that only the middle pipe runs through every baffle (Figure 5). Currently, only the Non-Overlapping case is used at all flow rates.

Documented Progress

In the AC flocculator code, there are four sections of code that construct the flocculation modules:

- Module Piping for Beginning Channels (overlapping)
- Module Piping for Last Channel (overlapping)
- Module Piping for Beginning Channels (non-overlapping)
- Module Piping for Last Channel (non-overlapping)

The Non-Overlapping case was modified first since this is the current structure used by water treatment plants at all flow rates. The end result is shown in Figure 6.

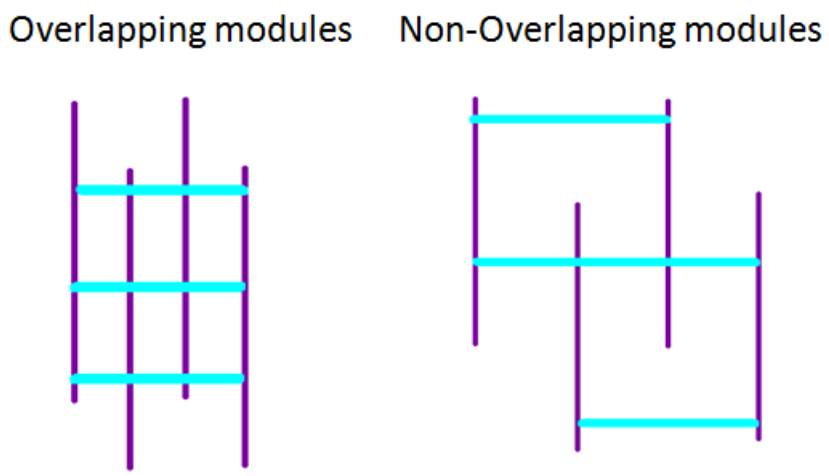

Figure 4: Overlapping and Non-Overlapping Modules (Sideview)

In "Module Piping for Beginning Channels (non-overlapping)," the existing variables "FlocModEndPipeUpper", "FlocModEndPipeMiddle", and "FlocModEndPipeLower" code for the last pieces of the pipes in each channel. First, to make room for the elbows, a length equivalent to the elbow radius plus twice the nominal diameter of the pipe is subtracted from the upper and lower pipes. Similarly, a length equivalent to the short tee length plus twice the nominal diameter of the pipe is subtracted from the middle pipe. The origins of the pipes are adjusted accordingly by subtracting the specified lengths from the x-coordinates.

Then, using the same origins of the corresponding end pipes, the upper elbow, middle tee and lower elbow are drawn in the new functions "FlocModEndPipeElbowUpper", "FlocModEndPipeTeeMiddle", and "FlocModEndPipeElbowLower", respectively. Next, two variables were created to calculate the lengths of the vertical pipes: "TopVerticalPipeLength" and "BottomeVerticalPipeLength". The lengths are calculated by taking the difference between two consecutive z-coordinates of the pipe origins and subtracting the elbow radius and half of the tee length from it. To illustrate, "TopVerticalPipeLength" is the z-coordinate of the upper end pipe minus the z-coordinate of the middle end pipe minus the elbow radius minus half of the short tee length. Using these lengths, "FlocModEndVerticalPipeUpper" and "FlocModEndVerticalPipeLower" then draws the vertical pipes. The origins of the vertical pipes are modified from the origins of the upper and middle end pipes to account for the addition of elbow radius in the x- and y-direction. To simplify the code, the length variables can be eliminated by directly substituting the quantities into the vertical pipe functions. Lastly, the new additions to the code are inserted into the stack function "FlocMod1NoOverlap," which accumlates all aspects of the flocculation modules to form one file.

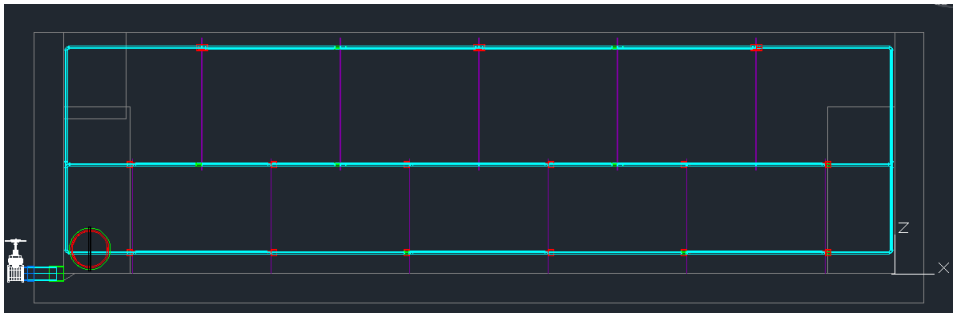

Figure 5: Sideview of 70 Lps Flocculation Tank with Pipes Connected

The same process takes place for "Module Piping for Last Channel (non-overlapping)" with slightly different variable names. For example, the name for the upper pipe is "EndFlocModLongPipeLastUpper" instead of beginning channels' "FlocModEndPipeUpper".

Future Work

Currently, none of the flow rates use overlapping modules so the "Overlapping" code was not modified. The Overlapping code uses different variables and different methods in drawing the baffles than the Non-Overlapping code., and will have to be modified if any additional flowrate in the future uses overlapping modules.