Depth of Flow in an Open Channel

# Abstract

The purpose of this exercise is to calculate the depth based on a flow rate to sound an alarm.

# Problem Statement

By using the Manning’s Equation we are able to find the depth at a specific flow rate. By iterating through the depth till the determined flow rate we can determine what the depth is when the alarm will need to be triggered. Various equations are used, but the main variables within the program are as follows: n, b, y, z, s, error, Q, feet and inches.

*Where:*

# Methodology

By iterating over the equation increasing y by the error rate the program is able to come up with an answer within 0.032% of the specified value which is 50 cubic feet a second. We accomplished this using a for-loop. The following code was used to solve the problem

'''

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Functions Part 1

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Variables:

n - is Manning's n for roughness of the bottom of the channel

b - Bottom width of channel (ft)

y - Depth of Channel (ft)

z - Side slope of the channel (horizontal)

s - Directional slope of the channel

error - The Step interval for the interation

array - The Array the promel iterates though 0-5

Q - The Flow of the Channel in (cfs - cubic feet/sec)

start - Start time saved

inches - Q is converted to remaining inches

feet - Q is converted to whole feet

'''

import math

import numpy as np

import time

def TrapezoidalQ(n,b,y,z,s):

# n is Manning's n - table at

# https://www.engineeringtoolbox.com/mannings-roughness-d\_799.html

# b = Bottom width of channel (ft)

# y = Depth of channel (ft)

# z = Side slope of channel (horizontal)

# s = Directional slope of channel - direction of flow

A = b\*y + z\*y\*y

W = b + 2\*y\*math.sqrt(1 + z\*z)

R = A/W

Q = 1.49/n \* A \* math.pow(R, 2.0/3.0) \* math.sqrt(s)

return Q

error = 0.001

b = 3

z = 2

s = 0.01

n = 0.022

start = time.time()

array = np.arange(1,2,error)

for i in array:

Q = TrapezoidalQ(n, b, i, z, s)

feet = math.floor(i)

inches = (i \* 12) % 12

if Q >= 50:

print(f'At {Q:.10f} cfs the depth of the channel is {feet:.2f} feet, {inches:.2f} inches!')

break

# Solution

The following assignment variables provided below in the table in red.

Table : Program Variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Flow Rate** | **Roughness Coefficient** | **Depth of Channel** | **Side Slope of Channel** | **Directional Slope of the Channel** |
| 50.016 | 0.022 | 1 foot 4.75 inches | 2 | 0.01 |

# Conclusion

The flow rate of the channel was the known value and through iteration we have found the unknown value (the depth of the channel). Iteration is a powerful tool to allow multiple values to be examined based on a given error rate. Coupled with this knowledge graphs can be made to show the direct relationships with the depth and flow rate.