TEXAS TECH UNIVERSITY

DEPARTMENT OF CIVIL, ENVIRONMENTAL AND CONSTRUCTION ENGINEERING

Lab Report #8: Open Channel

CE 3105-Fluid Laboratory

Section:

Group Number:

Members:

Date of Experiment:

Date of Submission:

Table of Contents

Theory 2
Apparatus 2
Parameter Measured 5
Results 6
Discussion 9
Data Appendix 10
Error Analysis Calculations 10
Sample Calculations 11

Theory

The main objective of this lab is to know how to calculate Manning's coefficient in a Flume and understand the behavior of a hydraulic jump. There are two types of open channels natural and man-made, the equation that control open channel flow is Manning's.

Manning Equation:

$$Q = \frac{K_n}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

$K_n$is a conversion factor

n is manning's roughness coefficient

A is cross sectional area.

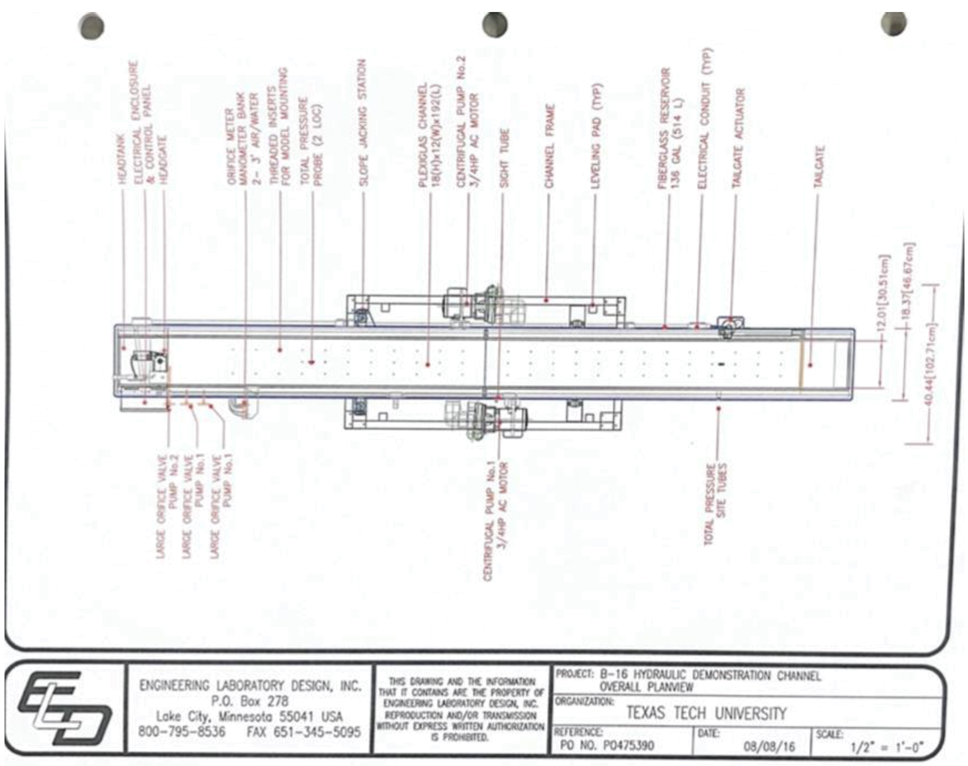
For Wetted Perimeter:

$$R = \frac{A}{W_p}$$

Wp -is wetted Perimeter

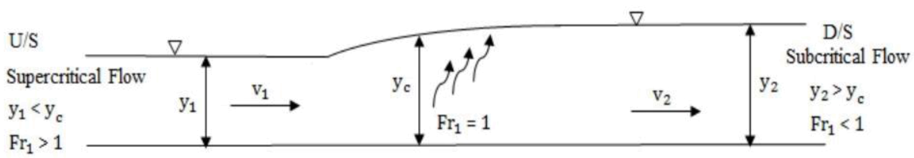
Apparatus

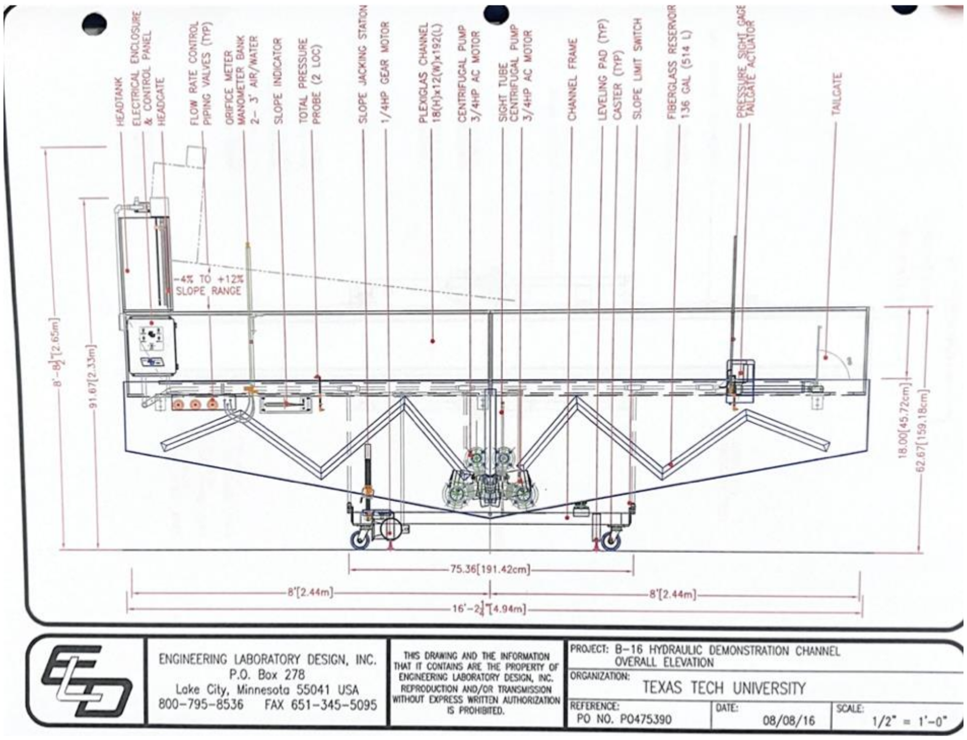
Figure 1: The figure below is the Open Channel Flume that was used in lab.



HEADTANK
ELECTRICAL ENCLOSURE & CONTROL PANEL
HEADGATE
ORIFICE METER MANOMETER BANK
2- 3' AIR/WATER
THREADED INSERTS FOR MODEL MOUNTING
TOTAL PRESSURE PROBE (2 LOC)
SLOPE JACKING STATION
PLEXIGLAS CHANNEL 18(H)x12(W)x192(L)
CENTRIFUGAL PUMP No.2 3/4HP AC MOTOR
SIGHT TUBE
CHANNEL FRAME
LEVELING PAD (TYP)
FIBERGLASS RESERVOIR 136 GAL (514 L)
ELECTRICAL CONDUIT (TYP)
TAILGATE ACTUATOR
TAILGATE
12.01[30.51cm]
18.37[46.67cm]
40.44[102.71cm]
LARGE ORIFICE VALVE PUMP No.2
LARGE ORIFICE VALVE PUMP No.1
LARGE ORIFICE VALVE PUMP No.1
CENTRIFUGAL PUMP No.1 3/4HP AC MOTOR
TOTAL PRESSURE SITE TUBES
ENGINEERING LABORATORY DESIGN, INC.
P.O. Box 278
Lake City, Minnesota 55041 USA
800-795-8536 FAX 651-345-5095
THIS DRAWING AND THE INFORMATION THAT IT CONTAINS ARE THE PROPERTY OF ENGINEERING LABORATORY DESIGN, INC. REPRODUCTION AND/OR TRANSMISSION WITHOUT EXPRESS WRITTEN AUTHORIZATION IS PROHIBITED.
PROJECT: B-16 HYDRAULIC DEMONSTRATION CHANNEL OVERALL PLANVIEW
ORGANIZATION: TEXAS TECH UNIVERSITY
REFERENCE: PO NO. PO475390
DATE: 08/08/16
SCALE: 1/2" = 1'-0"

Figure 4: The figure below shows a recurring flume.





Parameter Measured

1.Q, Flowrate ($\frac{ft^3}{s}$)

2.A, Cross-sectional Area (ft^2)

3.R, Hydraulic Radius (ft)

4.S, Channel Slope (dim)

5.n, Manning's roughness coefficient

6.Wp, Wetted Perimeter (f t)

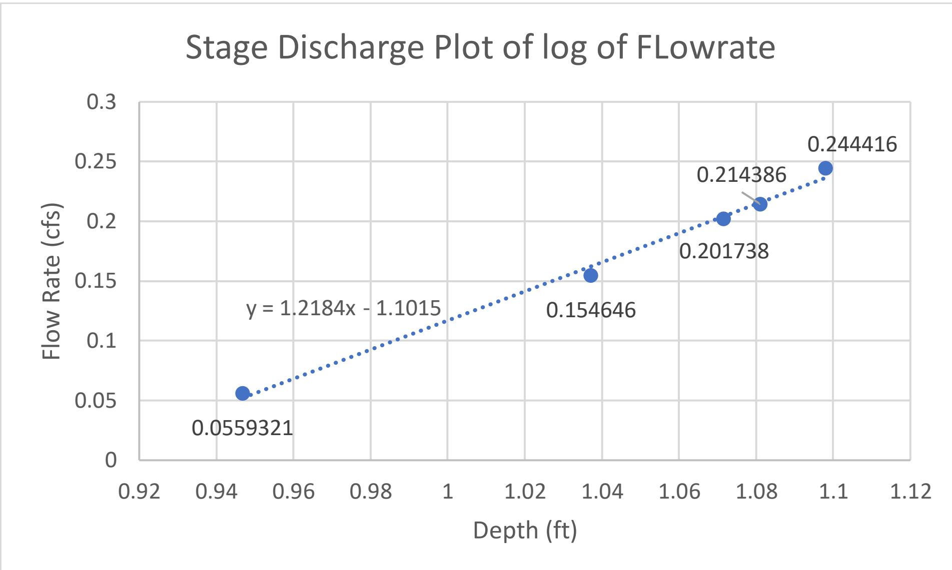
7.b, Width of Channel (= 1 f t)

8.Δ Difference of the manometers (f t)

9.h, Depth (in or cm)

Results

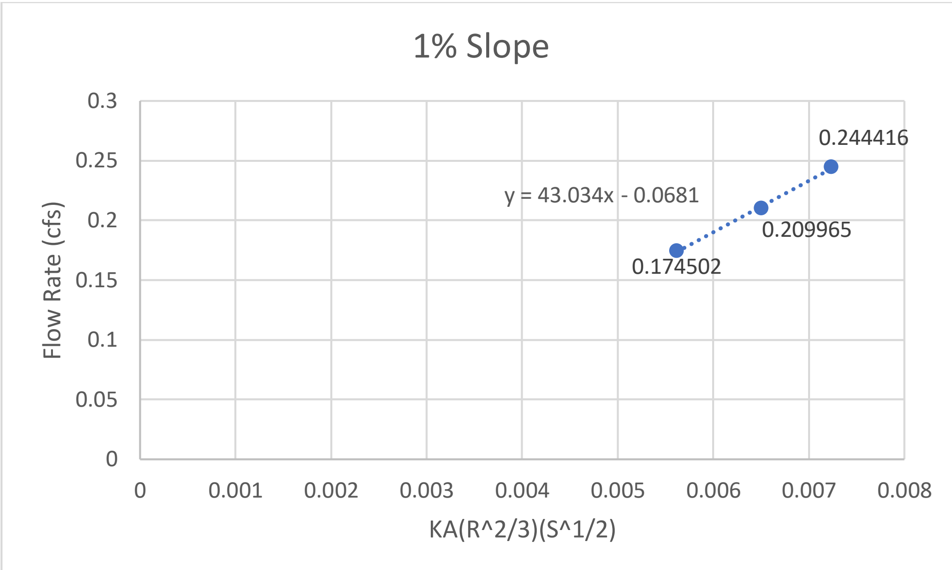
Part 1



Trial	Depth (feet)	ΔH (feet)	Q (cfs)
1	0.946875	0.07	0.055932
2	1.03725	0.59	0.154646
3	1.07171	1.03	0.201738
4	1.081125	1.17	0.214386
5	1.098042	1.54	0.244416

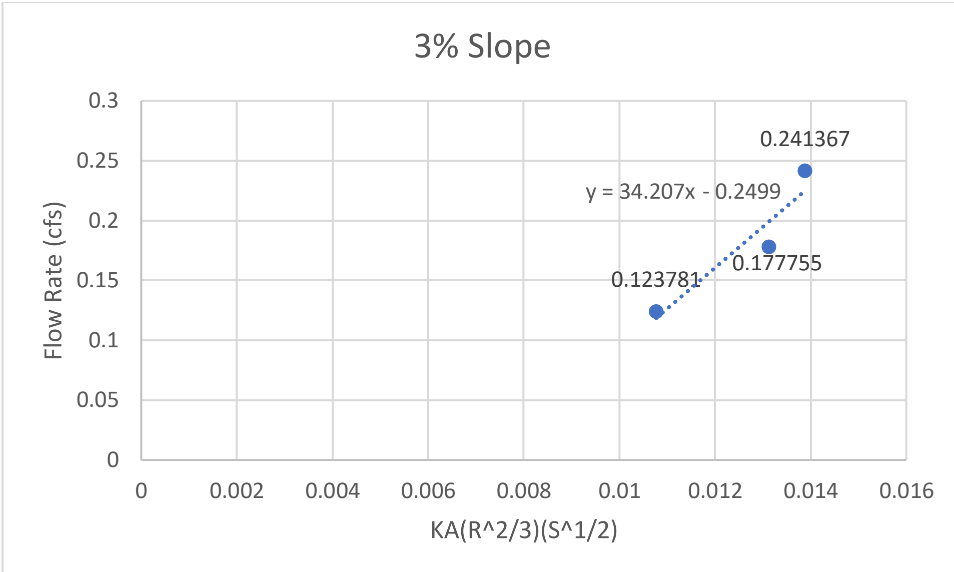
Part 2

<u>1% Slope</u>



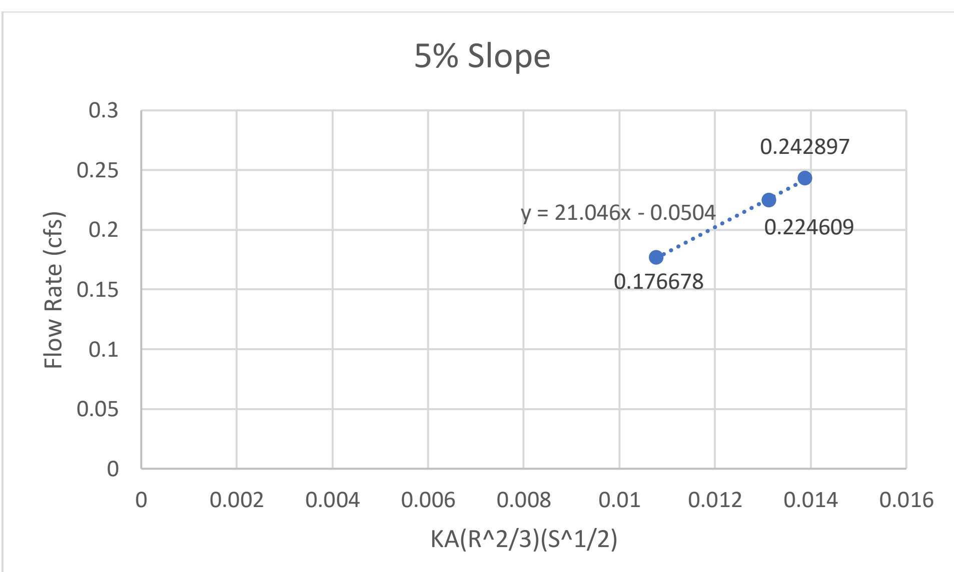
Trial	Wetted Perimeter (ft)	Hydraulic Radius (ft)	ΔH (ft)	Flow Rate (cfs)	Manning n
1	1.40758	0.14478	0.76	0.174502	0.0322004
2	1.45042	0.15527	1.12	0.209965	0.0309859
3	1.48475	0.163243	1.54	0.244416	0.0296197
Mean Manning n			Standard Deviation of n		
0.0309353			1.05404e-3		

3% Slope



Trial	Wetted Perimeter (ft)	Hydraulic Radius (ft)	ΔH (ft)	Flow Rate (cfs)	Manning n
1	1.31700	0.120349	0.37	0.123781	0.054063
2	1.39675	0.142026	0.79	0.177755	0.052618
3	1.45633	0.156673	1.50	0.241367	0.047584
Mean Manning n			Standard Deviation of n		
0.0514218			4.80957e-3		

5% Slope



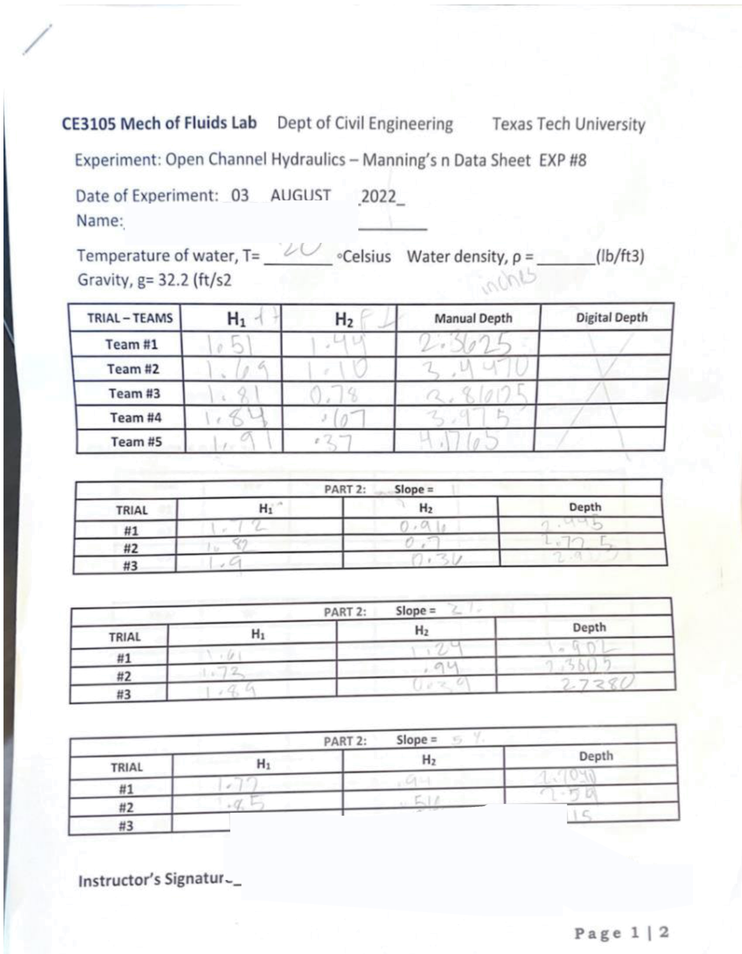
Trail	Wetted Perimeter (ft)	Hydraulic Radius (ft)	ΔH (ft)	Flow Rate (cfs)	Manning n
1	1.36733	0.134325	0.78	0.176678	0.0609685
2	1.420	0.147887	1.29	0.224609	0.0584652
3	1.43625	0.151871	1.52	0.242897	0.0571592
Mean Manning n			Standard Deviation of n		
0.0588643			1.580506e-3		

Discussion

1. The Manning's coefficient for a bed rock channel owing partially full is in the range of 0.035 - 0.050. How do your values compare to this reported range?
   The 1% slope falls into this range with an average coefficient of 0.03094, while the 3% and 5% slightly exceed this range with an average coefficient of 0.05142 and 0.5886, respectively.
2. Why is it important to know the channel bed material in a river or a stream?
   Different material has a different Manning coefficient. Knowing this coefficient, you can better design an open channel flow such as a canal or hydraulic dam because with the coefficient, the flow rate can be calculated. This in turn allows engineers to estimate the power output of a hydraulic dam.
3. Many rivers and streams have submerged vegetation. How would these vegetation affect Manning's n?
   Vegetation would cause an increase in the present friction forces. Therefore, the water would have a lesser flow rate than if it were to be a rock only bed. A lower flow rate would result in a higher Manning's coefficient due to their inversely proportional relationship.
4. What is the purpose of a Hydraulic Jump and where might it occur?
   Hydraulic jump often happens at the output of a system. Where a hydraulic jump were not to occur, the high output velocity could destroy the downstream ecosystem and make the area prone to flooding. A Hydraulic jump dissipates energy as high velocity streams are dampened by lower velocity water downstream.

5. Errors between experiment and theory have 3 possible sources; (a) inadequate theory (assumptions violated) (b) errors in experimental measurement (c) calculation errors Which do you think are most significant in your experiment, and why?
   Either errors in experimental measurement or calculation errors could be the cause of significant error. Inaccurate measurements would result in inaccurate results, regardless of whether or not calculations are done properly. However, accurate measurements could have been misused due to error in the calculations.

Data Appendix


CE3105 Mech of Fluids Lab   Dept of Civil Engineering   Texas Tech University

Experiment: Open Channel Hydraulics – Manning's n Data Sheet EXP #8

Date of Experiment: 03 AUGUST 2022

Name:

Temperature of water, T= 20 °Celsius   Water density, ρ = ______(lb/ft3)

Gravity, g= 32.2 (ft/s2

inches

TRIAL – TEAMS	H_1	H_2	Manual Depth	Digital Depth
Team #1	1.51	1.44	2.3625	
Team #2	1.69	1.10	3.4470	
Team #3	1.81	0.78	3.81025	
Team #4	1.84	.67	3.975	
Team #5	1.91	.37	4.1765	

PART 2: Slope = 1			
TRIAL	H_1	H_2	Depth
#1	1.72	0.96	2.445
#2	1.82	0.7	2.775
#3	1.9	0.36	[illegible]

PART 2: Slope = 3%			
TRIAL	H_1	H_2	Depth
#1	1.61	1.29	1.902
#2	1.73	.94	2.3605
#3	1.89	0.39	2.7380

PART 2: Slope = 5%			
TRIAL	H_1	H_2	Depth
#1	1.77	.94	2.7040
#2	1.85	.56	2.59
#3			15

Instructor's Signatur_

Page 1 | 2

Error Analysis

Slope	1%	3%	5%
1/n	32.33	19.45	16.99
m	43.03	34.21	21.05
Error Percentage	24.87%	43.15%	19.24%

Sample Calculations

Fluids Lab 8 | Sample Calculations

Wetted Perimeter (W_P)

$W = 1 ft$ $D = .1585 ft$

$W_P = 2D + W \rightarrow \underline{W_P = 1.317 ft}$

Area (A)

$D = .1585 ft$ $W = 1 ft$

$A = D * W \rightarrow \underline{A = .1585 ft^2}$

Hydraulic Radius (R)

$W_P = 1.317 ft$ $A = 0.1585 ft^2$

$R = \frac{A}{W_P} \rightarrow \underline{R = 0.120349 ft}$

Flow Rate (Q)

$R = 0.120349 ft$

$\log(Q) = \frac{\log(R) - 1.47}{2.096} \rightarrow \underline{Q = 0.123781 \, ft^3/s}$

Manning's Coefficient (n)

$Q = 0.123781 \, ft^3/s$ $A = 0.1585 ft^2$ $R = 0.120349 ft$ $S = .03$

$n = \frac{1}{Q} A R^{2/3} S^{1/2} \rightarrow \underline{n = 0.054063}$

Mean

$n_1 = .0540627$ $n_2 = .0526184$ $n_3 = 0.047554$ $x = 3$

$\bar{n} = \frac{\Sigma n}{x} \rightarrow \underline{\bar{n} = .051422}$

Standard Deviation (n)

$\bar{n} = .051422$ $x = 3$

$SD = \sqrt{\frac{\Sigma(\bar{n} - n)^2}{x}} \rightarrow \underline{SD = 4.80957e^{-3}}$