Determination Of Chezys And Mannings Coefficient For Different Aggregate Bed Using Different Notches In Hydraulic Bench

Bashir Muhtar, Manal M. A. Albayati

ABSTRACT: In this research project, Manning's and Chezy's constant were determined and compared, using four different notches with different coarse aggregate beds. The coarse aggregates sizes used are 10mm sized coarse aggregate, 20mm sized coarse aggregate, 40mm sized coarse aggregate, and 50mm sized coarse aggregate. Notches that were used in this experiment were the rectangular notch, trapezoidal notch, 90° V-notch and 60° V-notch. The experiment was carried out in the open channel Laboratory by using hydraulic bench, It was seen that, discharge coefficient varies indirectly with actual discharge. Chezy's constant is directly proportional to discharge While Manning's constant in inversely proportional to actual discharge. The Manning's and Chezy's roughness coefficient of different aggregate sizes were determined using the various notches. The experimental value of Manning's coefficient with the standard value of aggregates given in Manning's roughness table was evaluated. And also, the relationship of Manning's n with flow velocity, bed slope, and hydraulic radius were studied. The flow rate was measured straightforward since the procedures are obvious. The challenging phenomenon was determination of points where depth develops. The coefficient of resistance is more adaptable and accurate in manning's constant.

Key words: Open channel flow, coefficients of resistance, Manning's coefficient, Chezy's coefficient and Discharge coefficient.

1. INTRODUCTION

Hydraulics may be defined as that branch of engineering-science, which deals with water (at rest or in motion). The subject Fluid mechanics may be defined as the Mechanics of fluids [1]. The subject Hydraulic Machines may be defined as that branch of Engineering-science, which deals with the machines run by water under some head, or raising the water to higher levels. Water is still by far the most important of all fluids in earth processes and human life. The design of structures and other systems, and processes for its conservation are used as the field of hydraulic engineering or applied hydraulics [2]. Fluid mechanics is the general title given to the study of all aspects of the behaviour of fluids which are relevant to engineers. Within this very broad discipline, a number of subsections have developed. It has been provided by several researchers [3-5] that a fluid is a substance which can readily flow, which means in where there can be a continuous relative motion between one particle and another. In this experimental study, the coarse aggregates based on roughness will be taken into consideration profoundly in making the relevant estimations of different discharge coefficients for each bed type and in addition observe the water flow behaviour in each case. Notches containing different discharge formulae are used in making all required assessments and analysis.

- *Bashir. M1Student, Department of Civil Engineering, Infrastructure University Kuala Lumpur (IUKL), Malaysia*
- *Dr. Manal M. A. Albayati2 Head of Postgraduate Programme, Department of Civil Engineering, Infrastructure University Kuala Lumpur (IUKL), Malaysia*

2. EXPERIMENT PROGRAMME

From the literature [6] and other previous work [7-8], the aspect of this experimental research mainly deals with the broad study and determination of different water or fluids characteristics, behavioural and other mechanical properties which all are pertinent contents in hydraulics and water engineering. Water is considered to be a major constituent of living matter. It might be in motion or static giving rise to a categorizing division of hydraulics or water engineering, namely hydrostatics and hydrodynamics respectively describing each scenario. The tenacity of this laboratory research is the estimation of discharge coefficient, fluid characteristics in motion or hydrodynamics using notches for a different variety of beds in a man-made apparatus/channel. To expand on the principle sorts of channel, pipelines as likewise alluded to shut conductors hold an encased top of a conveyance channel regularly connected when coursing or conveying water/fluid in homes and plants while an open channel, for example, water bodies, watering system channels, dams involves the water/fluid opened or uncovered the climate. It is a need to comprehend open channels to effectively carry out the obliged experiment.

3. MATERIALS & INVESTIGATIONS

A - COARSE AGGREGATE: Sieve analysis test will have to be conducted in order to determine the grading or the size distribution of the aggregates to be used in this project experiment. Aggregates are characterized as latent, granular, inorganic materials which regularly comprise of stone or stone-like solids. Aggregates can either be natural or made. Natural aggregates are extracted from bigger rock framing (open exhuming- quarry) and after that decreased to usable sizes [9-10]. The majority of the amounts of the aggregates utilized as a part of practice are the natural aggregates. The sizes include 10mm, 20mm, 40mm and 50mm.

B - NOTCHES: In this project, the notches are made using Acrylic plastic (in form of a sheet) instead of using metal.

This is due to the fact that plastic is cheaper comparing to metal, so in order to reduce the cost plastic is used instead of metal. The notches include rectangular, 60^0 V-notch and 90^0 V-notch. Notches may be defined as an opening in one side of a tank or a reservoir, like a large orifice with the upstream liquid level below the top edge of the opening. Since the top edge of the notch above the liquid level serves no purpose, therefore a notch may have only the bottom edge and sides. The bottom edge, over which the liquid flows, is known as sill or crest of the notch and the sheet of liquid flowing over a notch (or a weir) are known as a nappe or vein. A notch is usually, made of a metallic plate and is used to measure the discharge of liquids [11-14]. Acrylic plastic (in form of a sheet) is the type of material used for fabrication of the selected type of notches.

C - WATER: Water is the most abundant and most widely distributed compound to a solid in the form of ice and snow; it covers the colder region of the earth. The liquid state as lakes, rivers, and oceans, it covers about three fourth of the earth's surface, sometimes reaching a depth of nearly six miles. It is present in the air as a vapour with often as much as 50,000 tons of it in the air over a square mile of the earth's surface. It is present in all living matter, indeed almost 65 percent of the human body is composed of water [15-16].

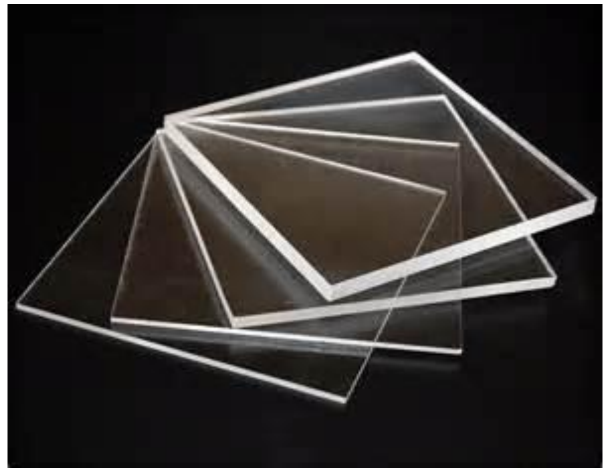

Figure 1: *Acrylic plastic*

Figure 2: *showing coarse aggregate*

ANALYSIS AND DISCUSSION

Table: 1 *10mm coarse aggregate using rectangular notch*

Rectangular Notch Obtained Data						
Run	Q	H	B	H^3/2	H^5/2	A
1	0.0005	0.058	0.248	0.01397	0.00081	0.0144
2	0.00067	0.063	0.248	0.01581	0.001	0.0156
3	0.00083	0.068	0.248	0.01773	0.00121	0.0169
4	0.001	0.075	0.248	0.02054	0.00154	0.0186
5	0.00117	0.081	0.248	0.02305	0.00187	0.0201
6	0.0015	0.085	0.248	0.02478	0.00211	0.0211

Calculated results					
P	V	R	Cd	C	n
0.364	0.0348	0.0395	0.0489	0.782	0.7463
0.374	0.0429	0.0418	0.0579	0.9383	0.6278
0.384	0.0492	0.0439	0.0639	1.0503	0.5655
0.398	0.0538	0.0467	0.0665	1.1122	0.5396
0.41	0.0582	0.049	0.0693	1.1768	0.514
0.418	0.0712	0.0504	0.0827	1.4171	0.4289
			0.0648	1.07945	0.57035

Table: 2 *10mm coarse aggregate using 90° V-Notch*

90° V-Notch Obtained Data						
Run	Q	H	B	H^5/2	A	P
1	0.0005	0.045	0.225	0.0004	0.001	0.1006
2	0.0007	0.048	0.225	0.0005	0.0012	0.1073
3	0.0008	0.053	0.225	0.0006	0.0014	0.1185
4	0.001	0.056	0.225	0.0007	0.0016	0.1252
5	0.0012	0.059	0.225	0.0013	0.0024	0.1543
6	0.0015	0.063	0.225	0.001	0.002	0.1409
Calculated results						
V	R	Cd			C	n
0.4938	0.0101	0.493			22.016	0.0211
0.5816	0.0107	0.562			25.106	0.0187
0.591	0.0119	0.543			24.277	0.0197
0.6378	0.0125	0.570			25.488	0.0189
0.6722	0.0132	0.586			26.173	0.0186
0.7559	0.0141	0.637			28.48	0.0173
		0.5652			25.257	0.019

Table: 3 *10mm coarse aggregate using 60° V-Notch*

60° V-Notch Obtained Data						
Run	Q	H	B	H^5/2	A	P
1	0.0005	0.056	0.136	0.00074	0.00157	0.1252
2	0.00067	0.059	0.136	0.00085	0.00174	0.1319
3	0.00083	0.062	0.136	0.00096	0.00192	0.1386
4	0.001	0.065	0.136	0.00108	0.00211	0.1453
5	0.00117	0.068	0.136	0.00121	0.00231	0.1521
6	0.0015	0.071	0.136	0.00134	0.00252	0.1588
Calculated results						
V	R	Cd	C		n	
0.3189	0.0125	0.494	12.74		0.03781	
0.3849	0.0132	0.581	14.99		0.03243	
0.4318	0.0139	0.6358	16.4		0.02988	
0.4734	0.0145	0.6807	17.56		0.02813	
0.5061	0.0152	0.7114	18.35		0.02712	
0.5951	0.0159	0.8188	21.12		0.02373	
		0.6536	16.86		0.02985	

Table: 4 *Manning's constant for 10mm coarse aggregate*

Q	Rectangular -notch	90° V-notch	60° V-notch
0.0005	0.782	22.016	12.74
0.00067	0.9383	25.106	14.99
0.00083	1.0503	24.277	16.4
0.001	1.1122	25.488	17.56
0.00117	1.1768	26.173	18.35
0.0015	1.4171	28.48	21.12

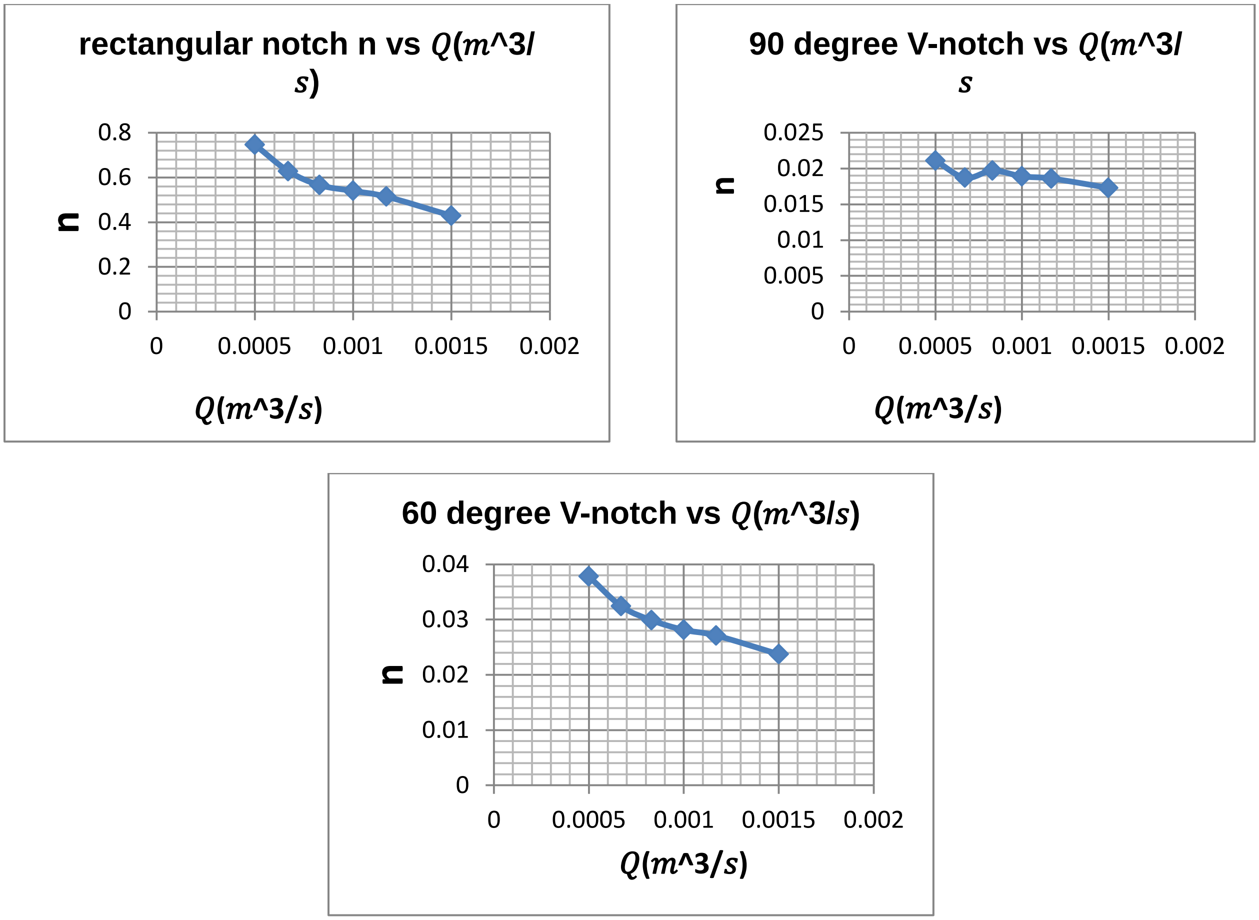

Figure 2: *Variation of Manning's constant with discharge of water for 10mm coarse aggregate*

Table: 5 *Manning's constant for 20mm coarse aggregate*

Q	rectangular n	60° n	90° n
0.0005	0.0537	0.0343	0.0237
0.0007	0.0459	0.0324	0.0209
0.0008	0.0408	0.0312	0.0197
0.001	0.0378	0.0343	0.0198
0.0012	0.0364	0.0316	0.0194
0.0015	0.0359	0.0275	0.0173

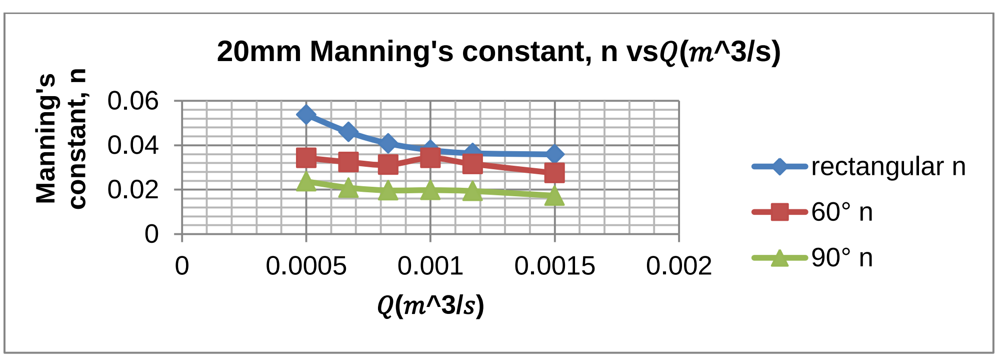

Figure 3: *Variation of Manning's constant with discharge of water for 20mm coarse aggregate*

Table: 6 *Manning's constant for 40mm coarse aggregate*

Q	rectangular n	60° n	90° n
0.0005	0.0335	0.031	0.0251
0.0007	0.0261	0.0296	0.0209
0.0008	0.0217	0.0286	0.0197
0.001	0.0193	0.0281	0.0189
0.0012	0.0173	0.0271	0.0194
0.0015	0.0148	0.0256	0.018

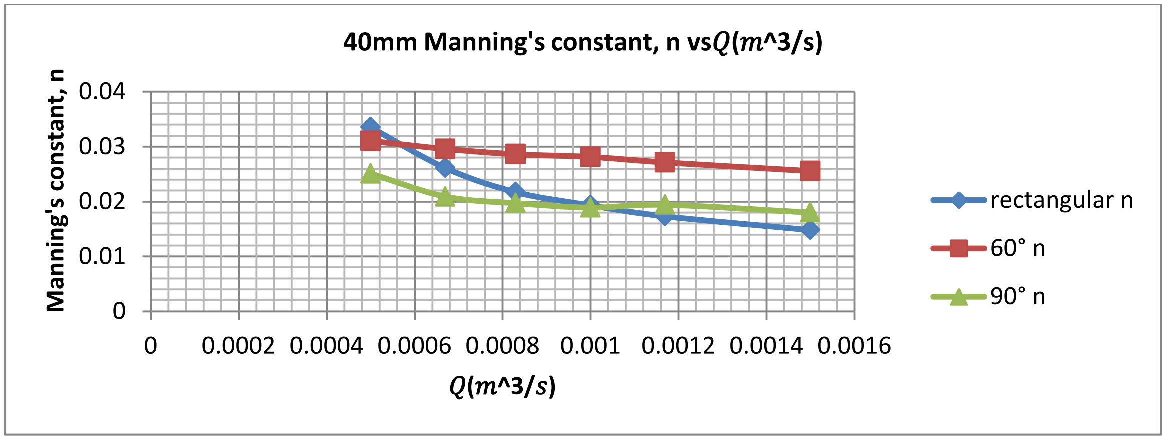

Figure 4: *Variation of Manning's constant with discharge of water for 40mm coarse aggregate*

Table: 7 *Manning's constant for 50mm coarse aggregate*

Q	rectangular n	60° n	90° n
0.0005	0.0379	0.0343	0.0199
0.0007	0.0296	0.031	0.0198
0.0008	0.0246	0.0312	0.0178
0.001	0.0216	0.0293	0.0189
0.0012	0.0197	0.0282	0.0186
0.0015	0.0169	0.0237	0.0152

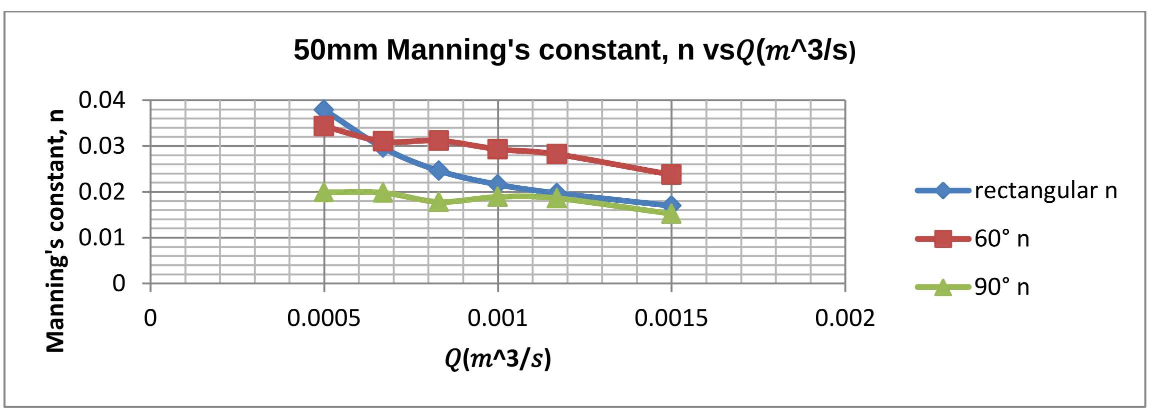

Figure 5: *Variation of Manning's constant with discharge of water for 50mm coarse aggregate*

Table: 8 *Obtained Chezy's constant for 10mm coarse aggregate*

Q	Rectangular -notch	90° V-notch	60° V-notch
0.0005	7.82	22.016	12.74

0.00067	9.38	25.106	14.99
0.00083	10.50	24.277	16.4
0.001	11.12	25.488	17.56
0.00117	11.76	26.173	18.35
0.0015	14.17	28.48	21.12

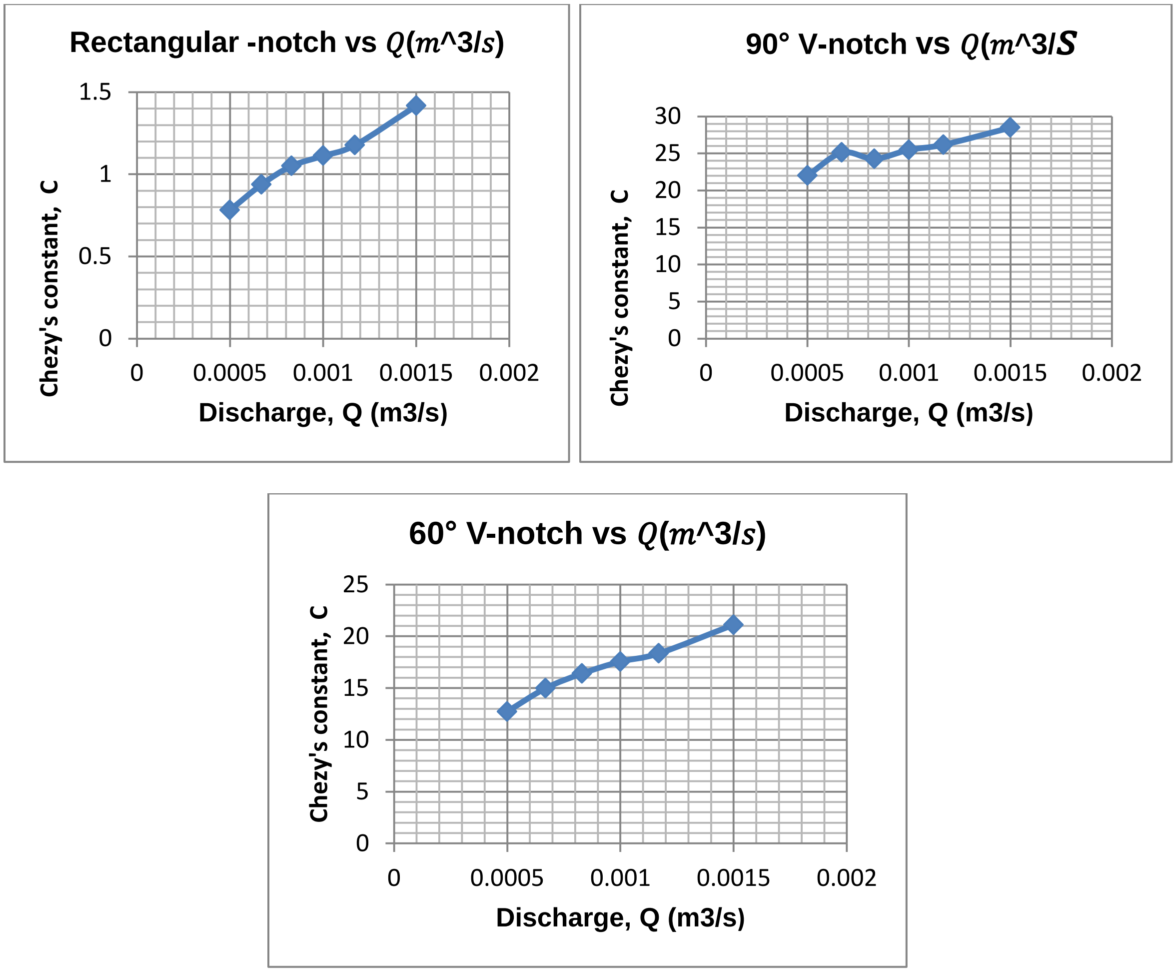

Figure 6: *Variation of Chezy's constant with discharge of water for 10mm coarse aggregate*

Table: 9 *Obtained Chezy's constant for 20mm coarse aggregate*

Q	rectangular C	60° C	90° C
0.0005	9.23	13.96	19.748
0.0007	10.88	14.99	22.67
0.0008	12.29	15.76	24.277
0.001	13.32	14.59	24.385
0.0012	13.91	15.91	25.096
0.0015	14.23	18.42	28.48

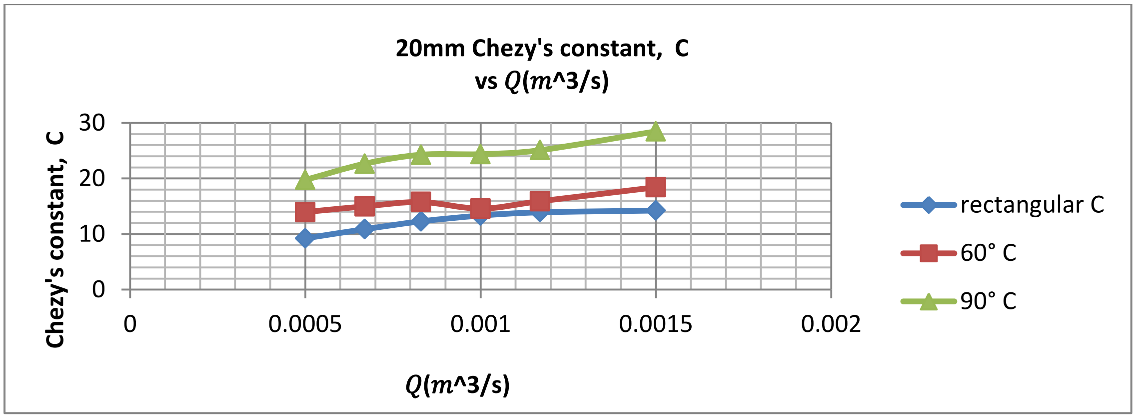

Figure 7: *Variation of Chezy's constant with discharge of water for 20mm coarse aggregate*

Table: 10 *Obtained Chezy's constant for 40mm coarse aggregate*

Q	rectangular C	60° C	90° C
0.0005	13.789	15.34	18.736
0.0007	17.701	16.34	22.67
0.0008	21.33	17.08	24.277
0.001	24.059	17.56	25.488
0.0012	26.781	18.35	25.096
0.0015	31.292	19.71	27.381

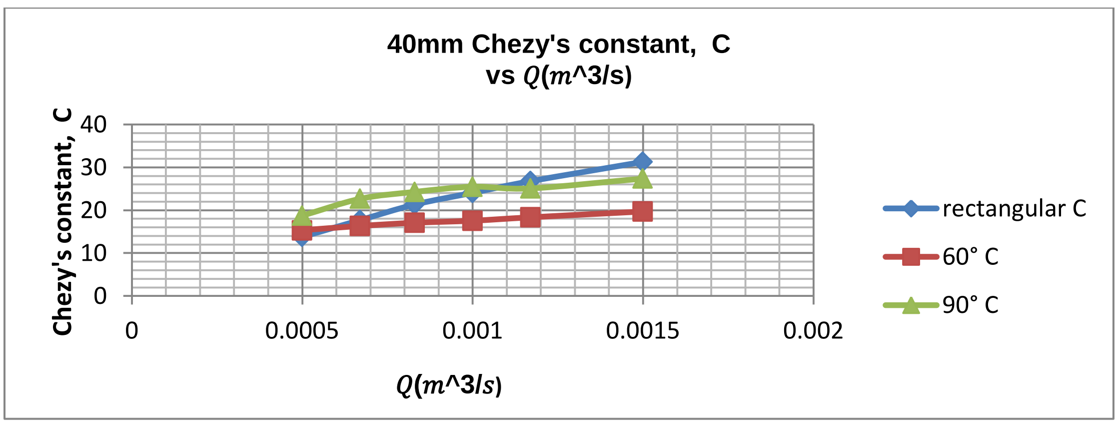

Figure 8: *Variation of Chezy's constant with discharge of water for 40mm coarse aggregate*

Table 4.13 *Obtained Chezy's constant for 50mm coarse aggregate*

Q	rectangular C	60° C	90° C
0.0005	12.36	13.96	23.288
0.0007	15.84	15.64	23.844
0.0008	19.07	15.76	26.727
0.001	21.75	16.9	25.488
0.0012	23.86	17.7	26.173
0.0015	27.81	21.12	32.175

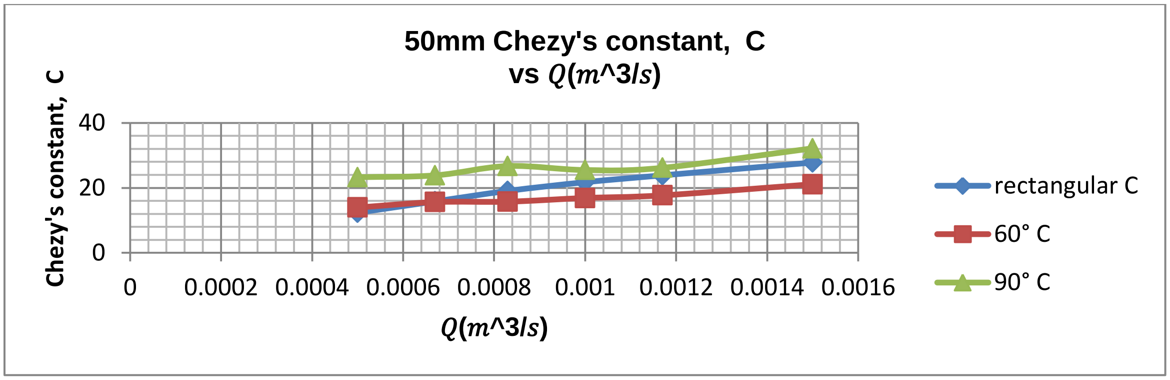

***Figure:** Variation of Chezy's constant with discharge of water for 50mm coarse aggregate*

Hydraulic bench was used to conduct the experiment. This experiment helps to achieve the relationship among discharge, different type of notches, discharge coefficient and Chezy's and Manning's constants. The different types of notches used are Rectangular notch, 60^o and 90^o V-notch, for 10mm, 20mm, 400 and 50mm coarse aggregate. The test was done six times per each type of notch so as to get six readings and to eliminate the errors. Therefore six different water flow rate (discharge) were selected ($0.0005m^3/s$, $0.00067m^3/s$, $0.00083m^3/s$, $0.001m^3/s$, $0.00117m^3/s$, and $0.0015m^3/s$), Then the value of hydraulic mean depth was measured per each selected discharge. This was done for each type of notch.

Formulas for calculating Discharge Coefficient are as shown below;

- **For rectangular notch**

$$C_d = \frac{Q}{\frac{2}{3} b \times \sqrt{2g} \times H^{\frac{3}{2}}}$$

$$C_d = \frac{Q}{\frac{8}{15} \times \sqrt{2g} \times \tan\frac{\theta}{2} \times H^{\frac{5}{2}}}$$

- **For 90° v-notch**

$$\mathrm{Cd} = \frac{\mathrm{Q}}{\frac{8}{15} \times \sqrt{2\mathrm{g}} \times \tan\frac{\theta}{2} \times \mathrm{H}^{\frac{5}{2}} \times \mathrm{Cd}}$$

- **For 60° v-notch**
- $\mathrm{Cd} = \frac{\mathrm{Q}}{\frac{8}{15} \times \sqrt{2\mathrm{g}} \times \tan\frac{\theta}{2} \times \mathrm{H}^{\frac{5}{2}}}$

Where by,

C_d = Discharge Coefficient
Q = Actual Discharge/ Water flow rate (m^3/s)
B = Width of a Channel (m)
H= Height of water level above crest (m)
θ = Notch's angle (degree)
g = gravitational force

In the investigation of resistance coefficient, Manning's and Chezy's constant were considered in this exploration detailed analysis. The normal resistance coefficients for each of the four bed materials are in like manner found to wipe out slip and suit a more extensive scope of relevance. Beneath shows tables and plotted charts of the different sizes of bed materials utilized within this experiment.

Chezy's Constant equation

$$V = C\sqrt{RS}$$

$$C = \frac{V}{\sqrt{RS}}$$

Where by $R = \frac{A}{P}$, A= wetted area in a channel while P= wetted perimeter in a channel.

Manning's Constant equation

$$V = \frac{1}{n} R^{2/3} S^{1/2}$$

$$n = \frac{R^{2/3} S^{1/2}}{V}$$

Where by,
Q = Actual Discharge
A = Flow cross section area
V = Mean velocity
R = Hydraulic mean radius
S = Bed slope
c = Chezy's constant
n = Manning's constant

Table 5: *Comparison between Chezy's and Manning's Constant*

	Chezy's constant	Manning's constant
1.	It has big value of chezy's constant.	It gives reasonable small value of Manning's constant.
2.	It has longest history of background	The history background is short.
3.	It is the source of most of coefficient of resistances. Example Manning's and Darcy- Weisbach	It originated from Chezy's constant
4.	It highly depend on velocity	It is not highly depending on velocity
5.	It has no generally recognized tables or figures. That is why it is not normally used.	It has generally recognized tables or figures. Example from Chow (1959) and picture book of Barnes (1967).That is why it is used frequently.
6.	Few researches and evaluations have been done.	Many researches and evaluations have been done which gives a proof that it is more accurate and adaptable.

CONCLUSION

In the present study the impacts of Manning's roughness n, Chezy's coefficient, slope S, and depth y, the notches were investigated particularly rectangular. The discharge was found to be decreased as roughness coefficient increases. An observational relationship is acquired to estimate the variety of estimation parameters and roughness coefficient. The hydraulic bench experiment was made in such a way to depict natural open channel. Based on the investigation, coefficient of discharge is directly proportional to water discharge for rectangular and 60° triangular notch although contradicts for coarse aggregates and 90° V-Notch with an inverse proportionality whereas increase in discharge of water causes decrease in the estimated coefficients of discharge.

REFERENCES

[1] ASTM (1993) American Society for Testing and Materials. ASTM D5242. Standard method for open-channel flow measurement of water with thin-plate weirs

[2] B.C. Yen, (2002). Open Channel Flow Resistance. Journal of Hydraulic Engineering

[3] Bengtson H. (2010) Open Channel Flow Measurement 4: the V Notch Weir [Online] Available at: http://www.brighthubengineering.com/hydraulics-civil-engineering/65701-open-channel-flow-measurement-4-the-v-notch-weir/

[4] Bengtson H. Harlan, (2011) Open Channel Flow Measurement-Weirs and Flumes.

[5] Chanson, H., (2004) the hydraulics of open channel flow.1sted.Amsterdam: Elsevier Butterworth Heinemann.

[6] Chow, P., (2002) Taiwan's modernization in global perspective. 1st ed. Westport, Conn.: Praeger.

[7] Delleur, J., (2006) Review of Wastewater Collection System Modeling and Design by TM Walski, TE Barnard, E. Harold, LB Merrit, N. Walker, and BE Whitman: Haestad Methods, Inc. Waterbury CT., 2004; ISBN 0-9657580-9-5; 605 pp. Price: 195,students 75, professors 30. Journal of Hydraulic

[8] Engineering, 132(3), pp.328--329. 12) Hershey, R., (2009) Streamflow measurement. 1st ed. London: Routledge. 13) Inc., E., (2014) Britannica Book of the Year 2014. 1st ed. Chicago:

[9] Encyclopaedia Britannica, Inc.Kirby JT, Durrans SR, Pitt R, Johnson D. (2005) Hydraulic resistance in grass swales designed for small flow conveyance. Journal of Hydraulic Engineering 131(1): 65–68. 15) Kothandaraman, C. and Rudramoorthy, R., (2006) Fluid Mechanics and machinery. 1st Ed. New Delhi: New Age International.

[10] Mays, L., (1999) Hydraulic design handbook. 1st e d. New York: McGraw-Hill. 20) Nicklow, J. and Boulos, P., (2005) Comprehensive water and wastewater treatment plant hydraulics handbook for engineers and operators. 1st ed. Pasadena, Calif.: MWH Soft, Inc. 21)

[11] Ramsay, H., (1993) Recycled waste? Debating the analysis of worker participation: a response to Ackers et al. Industrial Relations Journal, 24(1), pp.76--80. 22)

[12] Rhee, D., Woo, H., Kwon, B. and Ahn, H., (2008) Hydraulic resistance of some selected vegetation in open channel flows. River research and applications, 24(5), pp.673--687. 23)

[13] Ricketts, J., Loftin, M. and Merritt, F., (2004) Standard handbook for civil engineers. 1st Ed. New York: McGraw-Hill.

[14] Valvias.com (2007) Flow Coefficient Definition [Online] Available at: http://www.valvias.com/flow-coefficient.php (Accessed on 15th March, 2013)

[15] Www.tapplastic.com (2013) Acrylic plastic sheet [Online] Available at: http%3a//www.tapplastics.com/product/plastics/cut_to_size_plastic/acrylic_sheets_clear/508(Accessed on 25th August, 2013)