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Research Article

VELOCITY MEASUREMENT BY VARIOUS APPROACHES IN AN IRRIGATION CANAL

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Abstract: Water is the most valuable asset for irrigated agriculture. Water plays an important role in achieving maximum production of agriculture produce to feed the growing population. Judicious use of water in agriculture is gaining more and more importance and an accurate measurement of irrigation water permits an intelligent use of this valuable natural resource in an effective manner. In general, empirical equations are often applied to estimate mean velocity and discharge in irrigation canals. However, few real time measurement of velocity by various approaches is also possible and would be more appropriate in estimating velocity of water. In this study, various field methods were compared in finding out velocity of water. After getting accurate velocity, the discharge of any canal can be worked out by Area-Velocity approach to find discharge rates. In the present study, three different types of current meters (Universal, propeller and cup type) and different floating materials (apple, tomato, citrus, chilli, wooden piece and ball) were used for measurement of velocity in open canal. The percentage deviation of velocity either towards higher side or lower side in comparison to propeller type current meter was found out, since propeller type current meters are quite popular for open channel flow measurement. The results indicated that, in comparison to velocity obtained by propeller type current meter, the variation of 8.7 percent (higher side) was obtained by universal current meter and variation of 8.9 percent (lower side) by cup type current meter. Among the different types of floating materials, apple, tomato citrus, ball, chilli and wooden piece exhibited 2.4, 3.1, 3.9, 5.4, 6.1 and 8.6 percent (lower side) deviation of velocity respectively in comparison to propeller type current meter. The velocity variation in terms of percentage by various approaches was observed to be within 10 percent, which can be reliable for practical use under the situations where sophisticated instruments are not available for accurate measurement of velocity in canals.

Keywords: Velocity measurement, Canal discharge, Current meter

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Introduction

Water is an important natural resource for mankind and is a valuable national asset. Efficient development and optimum utilisation of water resources is of great significance to the overall development of the country. Accurate measurement of irrigation water results in more intelligent use of this valuable natural resource. Precise discharge measurements encourage conservation and best use of our limited water resources. Water management depends upon the ability to precisely measure the water. In general, empirical equations are often applied to estimate the mean velocity and discharge in canals and irrigation channels. The Manning's equation is the most popular one among the empirical equations. However, the Manning's equation is based on the concept of uniform flow and the roughness co-efficient and it is influenced by the factors such as velocity, hydraulic radius, hydraulic slope and Froude number. Applying the Manning's equation to estimate discharge in a non-uniform open channel flow will cause problem [3, 9, 5]. Various methods have been applied for estimation of discharge in irrigation canals. The velocity of water can be measured by different types of current meters (universal, propeller and cup type etc). In the places, where there are no much measuring facilities, often different floating materials are used for measuring velocity of water [2, 8]. The discharge rate in canal can be obtained by area-velocity method, in which velocity measurements are carried out by current meters, floating materials, empirical equations and advance techniques. Many scientists [1, 6] have experimented measurement of irrigation water in the regular shaped lined channels using simple measuring devices (weirs).
Material and Methods

Location of study area

For measurement of discharge from irrigation canal, the branch distributary No. 5 was selected near Gabbur village of Devadurga taluk in Raichur district, which actually originates from distributary No. 18 from Narayanapura Right Bank Canal (NRBC) in Upper Krishna Project. The lateral 2 which originates from branch distributary No. 5 was also considered for discharge measurement in irrigation channel.

Discharge measurement in irrigation canal and channels

The discharge measurement in irrigation canal (branch distributor 5) was estimated by area-velocity method. The straight canal section [Fig-1] was selected for measuring velocity of water.

Fig- 1 Straight canal section distributor No. 5


Fig-2 Universal Type Current meter


Fig-3 Propeller Type Current meter


Fig-4 Cup Type Current meter


Fig-5 Wooden as piece float material


Fig- 6 Apple as float material


Fig-7 Ball as float material


Fig-8 Citrus as float material


Fig- 9 Tomato as float material

The total discharge in the canal is equivalent to product of cross-sectional area of canal and velocity of water in the canal (Q=A*V). The velocity in the canal and channel was measured by using three types of current meter viz., universal, propeller and cup type current meters shown in Fig. 2 to Fig. 4

The floating materials such as ball, wood piece, apple, citrus fruit, tomato and chilly were used for measuring velocity of water by float method (Shown in Fig. 5 to Fig 9). However, the constant factor of 0.85 was multiplied with measured velocity by floating material to get the actual velocity of the canal. The various manning's roughness co-efficient values were considered for calculating velocity of water through manning's formula. After obtaining velocity of water by different approaches the discharge rates were calculated and comparisons were made between different approaches. The % deviation of discharge either towards higher side or lower side in comparison to propeller type current meter approach was done since propeller type current meters are quite popular for open channel flow measurement [8, 9].

The general formula for discharge measurement by area-velocity method is

$$Q = A*V \qquad 1)$$

Where,

Q = discharge rate of water, m3/s

A = cross-sectional area, m2

V = velocity of flowing water, m/s

Manning's formula for velocity measurement is as follows

$$v = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}} \qquad (2)$$

Where,

R is hydraulic radius (m) and

S is the hydraulic slope

Result and discussion

Discharge measurement in irrigation canal

The three types of current meters namely, Universal, Propeller and Cup type current meters were used for velocity measurement as a single point measurement at a depth of 0.6d (d = depth of canal) from top surface of the canal. The floating material like ball, wood piece, apple, citrus fruit, tomato and chilly were used as floating material for measurement of velocity. Similarly, Manning's formula was considered for velocity determination in a canal with different manning's roughness co-efficient. The discharge from the canal was computed using area-velocity method [Eq-1], in which velocity was calculated using Manning's formula [Eq-2]. The Manning's roughness coefficient values were chosen as per recommendations for lined channel. During the velocity measurement for each method, 15 trails were done to get average velocity of water. The average velocity of water was multiplied with cross-sectional area of canal to derive discharge measurement by area- velocity method. Among the various current meters, the velocity was observed to be more in universal type current meter (0.51m/s) followed by propeller type current meter (0.47 m/s) and cup type (0.42 m/s) current meters. Among the various floating material, the apple exhibited more velocity rate (0.455 m/s) followed by tomato (0.451 m/s), citrus fruit (0.448 m/s), ball (0.441 m/s), chilly (0.437 m/s) and wood piece (0.426m/s). Probably the smooth coat around apple and tomato may be the reason, where less resistance is offered by water as well as less amount of water is observed compared to other material may be the reason of exhibiting higher velocities by Apple and Tomato. The discharge rates obtained by various discharge measurement techniques were compared with each other, where in all methods were compared with propeller type current meter discharge measurement and the results are presented in the [Table-1]. Results revealed that, in comparison to propeller type method, universal type and cup type current meter methods exhibited discharge variation of 8.7% toward higher side and 8.9% towards lower side respectively. In comparison to propeller type current meter, the discharge rates exhibited by different floating material methods varied between 2.4 to 6.1% lower side. The least discharge variation was observed with apple (2.4%), followed by tomato (3.1%), citrus fruit (3.9%), ball (5.4%), chilly (6.1%), and wood piece (8.6%). Among the various manning's co-efficient (0.015, 0.025, 0.030, 0.035, 0.040) considered the least variation was observed (3.8%) with manning's roughness co-efficient of 0.035.

Table-1 *Variation in discharge of irrigation canal from various methods of measurement*

Sn	Velocity measurement method	Discharge, m^3/s	% variation
1	Propeller type current meter	0.5413	-
2	Universal type current meter	0.5885	8.7
3	Cup type current meter	0.4933	-8.9
4	Ball used as floating material	0.5122	-5.4
5	Wood piece used as floating material	0.495	-8.6
6	Apple used as floating material	0.5285	-2.4
7	Citrus fruit used as floating material	0.5202	-3.9
8	Tomato used as floating material	0.5243	-3.1
9	Chilli used as floating material	0.5081	-6.1
10	Manning's formula with n = 0.015	1.3106	142.1
11	Manning's formula with n = 0.025	0.7864	45.3
12	Manning's formula with n = 0.030	0.6553	21.1
13	Manning's formula with n = 0.035	0.5617	3.8
14	Manning's formula with n = 0.040	0.4915	-9.2

The $^{-}$ve Values of % variation values in the table indicates deviation towards lower side.
The $^{+}$ve Values of % variation values in the table indicates deviation towards higher side.

Discharge measurement in irrigation channel

The same methodology as applied for flow measurement in irrigation canal was repeated for measurement of discharge in irrigation channel. Similarly, Manning's formula was considered for velocity determination in a canal with different manning's roughness co-efficient. Among the various current meters, the velocity was observed to be more in universal type current meter (0.838 m/s) followed by propeller type current meter (0.79 m/s) and cup type (0.715 m/s) current meters. Among the various floating material, the apple exhibited more velocity rate (0.7637 m/s) followed by tomato (0.7566 m/s), citrus fruit (0.7268 m/s), ball (0.722 m/s), chilly (0.7176 m/s) and wood piece (0.7164 m/s). Probably the smooth coat around apple and tomato may be the reason, where less resistance is offered by water as well as less amount of water is observed compared to other material may be the reason of exhibiting higher velocities by Apple and Tomato. The discharge rates obtained by various discharge measurement techniques were compared with each other, where in all methods were compared with propeller type current meter discharge measurement and the results are presented in the [Table-2]. From Table 2 it is revealed that, in comparison to propeller type method, universal type and cup type current meter methods exhibited discharge variation of 6.2% toward higher side and 9.5% towards lower side respectively. Among various floating materials, all the floating materials exhibited % deviation towards lower side only in comparison to propeller type current meter. The least discharge variation was observed with apple (3.3%), followed by tomato (4.2%), citrus fruit (8.0%), ball (8.6%), chilly (9.2%), and wood piece (9.3%). Among the various manning's co-efficient (0.015, 0.025, 0.030, 0.035, 0.040¬) considered the least variation was observed (3.6%) with manning's roughness co-efficient of 0.015.

Table-2 *Variation in discharge of irrigation channel from various methods of measurement*

S	Velocity measurement method	Discharge, m^3/s	% Variation
1	Propeller type current meter	0.2161	-
2	Universal type current meter	0.2295	6.2
3	Cup type current meter	0.1955	-9.5
4	Ball used as floating material	0.1975	-8.6
5	Wood piece used as floating material	0.196	-9.3
6	Apple used as floating material	0.2089	-3.3
7	Citrus fruit used as floating material	0.1988	-8
8	Tomato used as floating material	0.207	-4.2
9	Chilli used as floating material	0.1963	-9.2
10	Manning's formula with n = 0.015	0.2084	-3.6
11	Manning's formula with n = 0.025	0.1251	-42.1
12	Manning's formula with n = 0.030	0.1042	-51.8
13	Manning's formula with n = 0.035	0.0782	-63.8
14	Manning's formula with n = 0.040	0.0893	-58.7

The $^{-}$ve Values of % variation values in the table indicates deviation towards lower side.
The $^{+}$ve Values of % variation values in the table indicates deviation towards higher side.

Conclusion

Water is the most valuable asset for irrigated agriculture. Water plays an important role in achieving maximum production of agriculture produce to feed the growing population. Judicious use of water in agriculture is gaining more and more important and an accurate measurement of irrigation water permits an intelligent use of this valuable natural resource in an effective manner. The experiment results indicated that, in comparison to velocity obtained by propeller type current meter, the variation of 8.7 percent (higher side) was obtained by universal current meter and variation of 8.9 percent (lower side) by cup type current meter. Among the different types of floating materials, apple, tomato citrus, ball, chilli and wooden piece exhibited 2.4, 3.1, 3.9, 5.4, 6.1 and 8.6 percent (lower side) deviation of velocity respectively in comparison to propeller type current meter. The velocity variation in terms of percentage by various approaches was observed to be within 10 percent, which can be reliable for practical use under the situations where sophisticated instruments are not available for accurate measurement of velocity in canals.

Application of research: This study clearly demonstrates the methodology and the selection of the instrument for the measurement of velocity in open canal with good efficiency

Research Category: Irrigation Management

Abbreviations:

m/s- Meter per second
%- percent
m3/s- meter cube per second
m - meter

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References

[1] Dursen O.F., Nihat Kaya and Mahmut Firat (2012) *J. Hydrology*, 4, 55-62.
[2] Kaur S., Rajan A., Satvinder S. and Harjit S.G. (2010) *J. Engg. and Tech. Research*, 2, 6 111-117.
[3] Singh J., Mittal S.K. and Tiwari H.L. (2014) *International J. Research in Engg. and Tech*., 3, 4 317-321.
[4] Chen Yen-chang A. and Chao-linchiu B. (2002) *J. Hydrology*, 265, 121-224.
[5] Reploge J.A. (2002) *J. American society of Agri Engg*.,18, 1 47-55.
[6] Badar Avinash M. and Aniruddha D. Ghare (2012) *International J. of Hydraulic Engineering*, 1, 5 37-42.
[7] Kumar S., Ahmad Z., Mansoor S., Himanshu K. (2013) *International J. of Recent Technology and Engineering*, 2, 1 24-28.
[8] Gandhi B. K. and Verma H. K. (2007) *International conference on small hydropower. Held during 22-24 October in Srilanka*.
[9] Michael A. M. (2007) *Irrigation (Theory and Practice), Vikas Publishing House, New Delhi*, 1-768.