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Hydraulic Evaluation of Neyrpic-Modules at Water Distribution Network of Garmsar Plain

[1]M. Jorabloo and [2]H. Sarkardeh,

[1]Department of Engineering, Water Engineering Group,
Islamic Azad University, Garmsar Branch, Garmsar, Iran
[2]Hydraulic Structures Division, Water Research Institute, Tehran, Iran

Abstract: During the recent years, the hydraulic performance of measurement devices has been considered as an effective factor on flow behavior investigation in irrigation networks. To reach this purpose, making more accurate measuring structures and methods is important respectively. Management to optimize water distribution and consumption in the networks plays an effective role in improvement of irrigation efficiency. Therefore, it is necessary for hydraulic structures to be the selected method, designed, constructed and operated in a way to optimize the efficiency as well as perform an effective water conveyance in to the fields. The Neyrpic-Modules are one of the important measurement devices in the Garmsar irrigation network system. The influence area of the irrigation network of Garmasar plain is about 32000 Ha. In the present work, the hydraulic performance of some Neyrpic–Modules which installed along the network canals were evaluated. Moreover, in a state of variable upstream depth, the passed discharge was measured. The error amount of Neyrpic-Gates, which operate with free downstream levels, was determined and its discharge coefficient was presented. In all tests, the theoretical and real discharges were compared to ensure that the Neyrpic-Modules work efficiently. Finally, by using collected data, all Neyrpic-Modules were calibrated.

Key words: Neyrpic-Module · Irrigation Network · Discharge Coefficient · Calibration

INTRODUCTION

The entire irrigation network should be in the best shape possible to achieve maximum uniformity and efficiency. To measure the flow rate of water in the irrigation network requires some means of water measurement. Scientific irrigation scheduling is a tool that tells to the manager when to irrigate and how much water to apply. This information is based on estimates of crop water demand and routine monitoring of the soil moisture conditions in the field. Another important factor is knowing the capacity of the irrigation network or how much water the irrigation network is capable of applying in a given time period. Generally, this requires an evaluation of the irrigation network to determine any losses or non-uniformities which could occur during the application. Most irrigation district farm delivery gates are equipped with some type of water measurement device, such as the Neyrpic-Modules (Fig. 1).

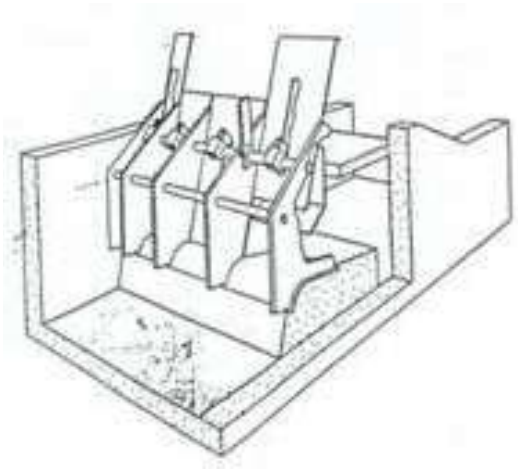

Fig. 1: Schematic shape of Neyrpic-Modules

In irrigation networks, water does not use with full uniformity or efficiency. These losses must be evaluated for each irrigation network. Also, they could be variable from one irrigation network to another.

Corresponding Author: M. Jorabloo, Department of Engineering, Water Engineering Group, Islamic Azad University, Garmsar Branch, Garmsar, Iran, E-mail: jorabloo.mehdi@yahoo.com.

An irrigation network with good efficiency saves water by allowing farmer to avoid over irrigating parts of the field while concentrating on putting adequate water on dry or other problem areas. An evaluation of irrigation network will provide the necessary information for scientific irrigation scheduling. It will also help the manager to experience excessive application losses and when the irrigation network needs service or improvement to increase its efficiency. The main aim of an irrigation network evaluation is determining how water is distributed and where it is going. Finally saving water is goal. Stated in a slightly different context, evaluating and improving network will help to stretch available water further. Operate irrigation networks near their design limits to achieve peak efficiencies and uniformities.

Literature Review: Considered design criteria in each irrigation network are different in order to select and design the control structures and withdrawing water in each country in the world. Therefore, regarding these differences, a little information and reports of these structures in actual situations and applied design criteria as well as procedures of modification and the ability to reconstruction of them are available. In this case some researches had been done. United Nation Office of Technical Cooperation had done a research in the field of intake performances [1]. Ghamarnia had done his research on several irrigation networks of Iran. His research was focused on selecting a monitoring method for intake structures [2]. By surveying Qazvin irrigation network, Bouchali Safiee performed a comprehensive study on performance of full-automatic and semi-automatic water distribution systems at network [3]. Razavi Nabavi investigated on discharge coefficients of Neyrpic-Modules in irrigation network of Qazvin plain and recommended applying Neyrpic-Modules in under construction irrigation networks. He also observed errors which are related to manufacturing methods and changing the hydraulic coefficient. In his research it is found that flow approaching situation to gates or gates location rather than the side walls, will have many effects on the outlet flow hydraulic. Moreover, he recommended that in all irrigation networks which are equipped with Neyrpic-Modules, before starting the operation and then every couple of years (for some five years) existing modules should be water proofed [4]. Salemi conducted his studies on hydraulic performance assessment and operation of flow control structures in irrigation networks of Zayandehrood and Dorodzan Rivers in Fars province, Iran. As the result of this research, using of Neyrpic-Modules is recommended because of a better control on networks, especially for regions that users have a higher awareness [5]. Montazer and Kouchakzadeh had worked on different relations of hydraulic sensitivity of Neyrpic-Modules and prepared characteristics of rating curves in basis of the field data, for sensitivity study during the operating periods. They expressed that hydraulic sensitivity in Neyrpic-Modules at local situations is more than present in the typical curves [6]. Pilpayeh accomplished a comparison between theoretical and measured discharge coefficients of Neyrpic-Modules which are established at the beginning of third grade irrigation network in Moghan plain. He concluded that it should act as free downstream and most of second grade network of Parsabad region irrigation, Neyrpic-Modules does not have required hydraulic mechanical accuracy and also because of the poor protection, the Neyrpic-Modules always are disturbed and rubbed [7]. One of the recent researches in Iran was carried out by Kazemi Mohsen Abadi and Zaker Fathi. They studied the Qazvin plain irrigation network. By analyzing the performance of intakes and checking structures, they stated that impoundment of canals had encountered many difficulties by reason of turnout and check gates touched by operators, lack of proper management for Amil Gate adjustment and sediments empty in canals, so that, some turnout gates have discharged more than nominal and computational discharge, that caused the water shortage in final gates. Moreover, they observed that some turnout gates delivered water to downstream canals less than nominal and computational discharges by reason of gate submergences and retouching. Lack of suitable services by network supervisors and accumulation of sediment and rubbish in back of the check gates more than nominal head loss in water way. Their results indicated that Neyrpic–Modules will have satisfied accuracy of water delivery, if check structures are controlled. It is also necessary to create proper instruction for control of home-made turnout gates. Finally, radial gates, slide gates and or fixed weirs are used for water level adjustment is recommended by them if irrigation network operation is not good [8].

MATERIAL AND METHOD

In the present work, by studying the available design of different components of networks and by evaluating the performance of Neyrpic-Modules, discharge and depth of the water were measured at downstream to

calibrate the gates. For determining discharge coefficient, the discharge of gates was determined and was compared with measured discharge at downstream and nominal discharge that should be crossed in the gate. Afterwards investigation of performance shows control gates according to crossing flow head loss from these structures. In suitable sections of upstream and downstream, where the gates are located, current flow turbulence was lower. Depth and water velocity were measured in all cases. It should be noted that, derivation of head loss which the designer had anticipated for each gate was very hard work. It must be mentioned that in order to complete performance evaluation of Neyrpic-Modules, six intake gates were examined in this study.

RESULTS AND DISCUSSIONS

Considering the measurement results, the measured depth on weir crest, in most gates was more than their initial values. After performing surveys it was evidenced that the increase of water depth in upstream intakes and the nominal depth are closely interconnected because of reasons such as the increase of the canal roughness coefficient, the canal side erosion due to passing of time, a lot of sediment inside the intake canal and behind the intake gate. In spite of depth increase behind the intake gate, it was observed that in most evaluated cases; the amount of measured discharge was less than the calculated discharge determined by the charts. Our residential surveys and investigations showed that in all these gates, the flow overtopped them and this matter decreased the passing discharge in comparison to the calculated discharge which passed from gates. The other main reasons which were observed, in difference between

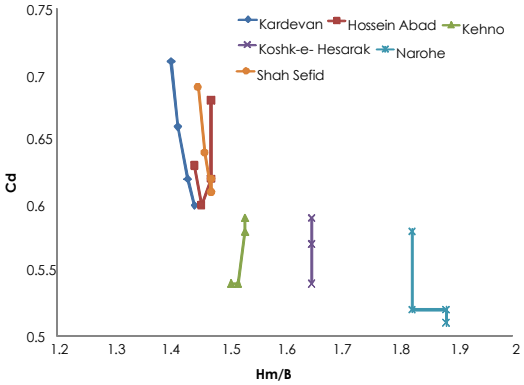

Fig. 2: Comparison C_d between all cases

the measured discharge and the calculated discharge in Neyrpic-Module, overtopping water gates due to the increasing of water depth in gates upstream because of the increased roughness coefficient, disturbing the intakes by farmers, leakage of water from the closed gates behind, water escape from the sides of gate and leakage of water from under the mask. After performing many experiments, it was found that it was better to derivate relations that make use of them simpler. The relations suggested for use of module gates, Neyrpic type, in the irrigation network of Garmsar plain are shown as Table1. The C_d was calculated from below equation:

$$Q_m = b_w C_d \sqrt{2 \times g(H_m - \left(\frac{w}{2}\right))} \quad (1)$$

Where b = width of gate opening, w = depth of water of the gate, H_m = depth of water in the upstream of the gate, Q_m = measured discharge, C_d = discharge coefficient of the gate.

Table 1: Suggestive relations for Neyrpic type (XX_2) module gates

Q_m	*Range of height changes*	Q_m	C_d
$30 \leq Q_m \leq 60$	$H_m = 27$	$Q = 12{,}74e^{0.02Q_m}$	$C_d = 0.50e^{0.140\left(\frac{b}{t}\right)}$
$Q_m = 50$	$25 \leq H_m \leq 32$	$Q = -0.30h^2 + 17.45h - 208$	$C_d = -0.30\left(\frac{b}{h}\right)^2 + 6.64\left(\frac{b}{h}\right) - 2.45$

Table 2: Amounts of discharge coefficient of the Neyrpic-Modules in irrigation network of Garmsar plain

Gate Name	Designing Discharge (LPS)	Passing Discharge (LPS)	C_d
Kardevan	273	291	0.64
Hosain Abad	236	242	0.63
Kehno	169	157	0.56
Koshke-e-hesarak	177	167	0.57
Narohe	296	261	0.53
Shahe sefid	2.40	1538	0.64

According to Table 2, it is considered in all cases passing discharge is lower than designed discharge amount. This matter has originated from channel discharge decrease, because of water requirement decline.

Figure 1 shows that amounts of discharge coefficient of Neyrpic gates in exploiting situations are more than nominal amounts. It has been specified that sediments, lack of proper adjustment and disturbing them by farmers due to that subject. It was observed that measured discharge is lower than designed discharge in some gates.

The following results and suggestions were concluded from the present field work:

Water overtopping from the gate causes the increased discharge delivery to farmers in some gates and decreases the rest of the discharge in the canal for downstream intakes.

Age and erosion of gates caused inefficiency and some of them must be replaced. The age of gate lets water leak from closed gates sill and increases the delivered discharge.

Water passing through the gates mask causes the passing discharge under the gate, which is more than the nominal discharge or delivered discharge.

Sediment behind the intake and Neyrpic gates decreases the coarseness coefficient of flow and this has decreased passing discharge in some gates.

The presence of excess sediment in the intake canal may cause many problems.

During the time of the canal erosion, their roughness coefficient increases and it adds to the depth of water behind the intake gates, therefore increases the water discharge for non-submerged gates.

Neyrpic type modules which operating as weir; are too sensitive to change of upstream head. Therefore should create a condition to convert the gates from a weir to an opening. This condition will be created, if Amil adjustments and dredge of intake canal is done properly. By adjusting the Amil gates, water is distributed accurately. Adjustment is better to be done in the full water and low water for canals.

By training the farmers and adequate supervision for the irrigation network, most of the problems can be solved.

Repairing the destroyed points of the canal networks and dredge of canal sediment leads to increase the efficiency of distribution and conveyance.

Exact studies on culture, traditions, customs, the way of irrigation and the regions that we consider to construct network have paramount importance. Because of the mode of exploiting the network is very important.

SUMMARY AND CONCLUSION

The shortage of rainfall, non–uniform distribution and, generally, the deficiency of water resources in Iran, dictates the optimization of water resources as a great duty of water engineers. In this regard, irrigation networks are constructed to provide an effective use of water conveyance and distribution. For this purpose recognition of effective factors in low irrigation efficiency, performance of check structures and turnout gates in Garmsar irrigation network were evaluated. In this study, used turnout and check gates were considered in different viewpoints; in hydraulic, operation and maintenance conditions. Hydraulic assessment includes discharge and upstream water head level. In this research, the hydraulic performance of six Neyrpic–Modules was evaluated. It was also concluded that after passing about 20 years of network construction and operation, in technical and cultural reasons, the irrigation network needs to be repaired and replaced in some situations to get more efficiency in water distribution. Also, existing amounts of sediment in the network may cause many problems in its operation and needs to be maintained. Moreover, it should be noted that the accuracy of the measurements in fields is low and this fact in the Garmsar irrigation network is more considerable.

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