Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 8, S. 228-232, 7, 2024

Araştırma Makalesi

IJANSER

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 8, pp. 228-232, 7, 2024

Research Article

https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

EVALUATION OF SEEPAGE LOSSES FROM LINED AND UNLINED IRRIGATION CANAL

Faridullah Khan*, Dr. Hamza Farooq Gabriel [2], Hassan Akhtar [3] and Muhammad Zaheer [4]

[1]*NUST Institute of Civil Engineering (NICE), Islamabad, Pakistan*
[2]*NUST Institute of Civil Engineering (NICE), Islamabad, Pakistan*
[3]*NUST Institute of Civil Engineering (NICE), Islamabad, Pakistan*
[4]*NUST Institute of Civil Engineering (NICE), Islamabad, Pakistan*
*faridkhan4445@gmail.com,

(Received: 24 August 2024, Accepted: 29 August 2024)

(5th International Conference on Engineering and Applied Natural Sciences ICEANS 2024, August 25-26, 2024)

ATIF/REFERENCE: Khan, F., Gabriel, H. F., Akhtar, H. & Zaheer, M. (2024). EVALUATION OF SEEPAGE LOSSES FROM LINED AND UNLINED IRRIGATION CANAL. *International Journal of Advanced Natural Sciences and Engineering Researches*, 8(7), 228-232.

Abstract – Water is an extremely valuable natural resource. When this valuable resource travels through the canal, some of the water is lost due to seepage. Seepage is a primary source of water loss during transportation. The primary goal of this research is to estimate seepage loss. from two different types of lined canals plain cement concrete (PCC) lined canal and bricked lined canal and one branch canal which is unlined. The most accurate way to measure seepage loss is to use the inflow-outflow approach. This research was commenced at PCC lined canal from RD 00+00 to RD 68+500, brick lined canal from RD 68+500 to 131+00 and Unlined canal from RD 00+00 to RD 47+00 which originate from head Pakka of Thal canal, Mianwali. The result shows that the average losses in PCC canal, brick canal and unlined canals were 2.25%, 6.04% and 19.07% respectively. The average conveyance efficiency of unlined canal is 81.93% which is very low as compared to PCC and brick canals 97.75% and 93.96% respectively. It was estimated that PCC and brick lining will reduce the seepage losses by 16.82% and 13.03% respectively.

Keywords – Conveyance Efficiency, Inflow-Outflow, Irrigation Canal, Seepage Loss.

I. INTRODUCTION

Water is a valuable gift of Nature. It's useful in many aspects of human existence. The need for this natural resource is growing daily because of the population growth. [1]. In a running day the requirement of water is more than its supply. So, it is a dire need of time to take measures to overcome water losses increase during conveyance of water. Conveyance losses in distributaries are about 25%. [2] In Sindh, Pakistan, tertiary irrigation networks showed water losses of more than 40%, While [3] found that distributary canals in Punjab, Pakistan, lost more than 45% of their water. [4] It is estimated that water losses during conveyance account for between 20 and 70 percent of global canal flows. According [5] seepage losses from the entire canal flows that were diverted to farmlands were found in Spain to the amount of about 55% [6]. Comparing the average seepage losses of 43.5% from lined to the average seepage losses of 66% from earthen water courses, he found that the lining decreased seepage loss 21.5%. It has a very incremental effect on agriculture crop productivity. In our country Pakistan's large way of groundwater availability is the Indus Basin Irrigation System (IBIS), which includes of a network of

reservoirs, dams, head facilities, linking channels, major rivers, distributors, watercourses, and small watercourses. Loss rates vary with length of watercourse, variability of discharge, retention time, form of soil, and soil density [7]. Conveyance losses include both evaporation and seepage loss. The main causes of evaporation losses are high temperature, moisture, and wind velocity. Essentially, evaporation losses cannot be treated, but flow losses can be managed between porous soil and channel discharge by supplying various materials such as brick lined, PCC lined, asphalt materials and geo-synthetic materials etc. In canals the major reason for water losses is the seepage loss as compared to other forms of losses [8]. A large amount of water is misplaced from irrigation canal due to seepage from banks. Water loss between the canal head works and the farm gate is estimated to be between 40% and 50%. 40% to 50% of seepage losses reduced in lined canal, subsequently logging of water become insignificant. Increased conveyance efficiency from 69% to 91% resulting in a significant rise in cropping amount. The seepage rate was shown to vary with canal design when the seepage losses were estimated using the inflow-outflow method. [9].

From the above discussion, it has been revealed that losses in the different types of lined canal have not been estimated in Thal canal and these losses were also not compared to unlined canal. In both lined and unlined canals, seepage loss is the only substantial loss that happens. It is, therefore, the need to study these losses in different types of lined and unlined canals. This study will benefit in more availability of canal water for agriculture productivity.

II. DATA COLLECTION AND METHODLOGY

The following sections give a detailed description of the study area, data gathering procedures and methodology used in this study.

A. Study Area

The Thal canal under consideration is located in District Mianwali, province of Punjab as shown in Figure 1. The coordinates of Mainwali district are 32º.55'06.71'N, 71º.31'18.9E having an elevation of 190 m to 210 m above MSL. Most of the district lies in the Thal desert region. The Indus River flows through the district. The temperature ranges from 0 ˚C to 52 ˚C. Mean annual precipitation is quite less and ranges from 150mm to 200mm. The total length of the Thal canal irrigation network is 3362km. Cotton, wheat, sugar cane and rice are the most important crops grown in the area. Schematic diagram of study area as shown in Figure 2.

Fig. 1 Arial view of study area

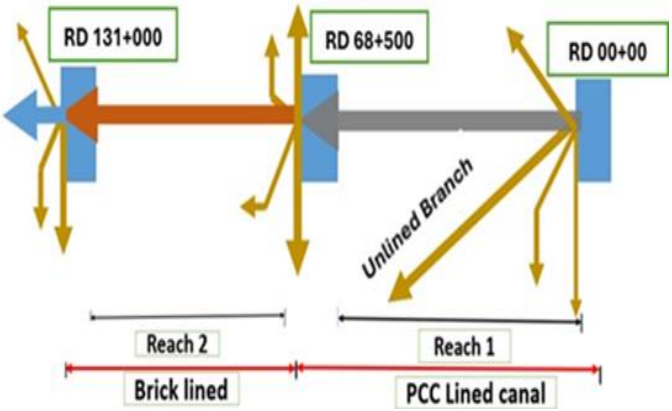

Fig. 2 Schematic diagram of study area

B. Data Collection

Historical discharge data was collected from the Irrigation Department of Punjab, Pakistan. Measurements of seepage loss using the inflow-outflow technique. The selection of Thal canal main line lower, one unlined canal whose name Mohajir branch (from RD 00+00 to RD 47+000) and main lined canal PCC lined reach (from RD 00+00 to RD 68+500) and brick lined reach (from RD 68+500

to 131+000) was selected in district Mianwali, Punjab (Pakistan). Gauges were already installed at head and tail by Punjab irrigation department for data collection of discharge at these points on daily basis.

C. Methodology

The Inflow-Outflow technique measures the volume of water that enters a channel at the section's inlet (Q_{in}) and the volume of water that exits the channel at the section's tail (Q_{out}) while no water is being directed between the two measurement locations in a practical manner. The term "loss" refers to the variation between these two measured values (Q_L). Measure the total volume of water or, provided the channel is flowing continuously with no difference in the recorded flow rate at either end, the flow rates directly [10]. Since evaporation losses from just 0.3% of the total losses recorded from the irrigation network, it has not been considered in this study [11,12].

$$Q_l = Q_{in} - Q_{out} \quad (1)$$

$$\text{Percent seepage losses} = \frac{Q_{in} - Q_{out}}{Q_{out}} \times 100 \quad (2)$$

$$\text{Percentage conveyance efficiency} = 100 - \text{water loss percentage} \quad (3)$$

III. RESULTS AND DISCUSSION

This study determined seepage losses for branch canals with PCC, brick, and unlined surfaces using the inflow-outflow approach. As indicated in Table 1, the research showed that the PCC-lined canal had the lowest seepage loss (2.25%) and the maximum conveyance efficiency (97.75%). At a seepage loss of 6.04% and a conveyance efficiency of 93.96%, the brick-lined canal showed moderate performance (Table 2). In comparison, the unlined branch canal exhibited the greatest seepage loss (19.07%) and the lowest conveyance efficiency (81.93%) (Table 3). Figures 3 and 4 show the comparative performance of the various canal linings, emphasizing the better efficiency of PCC lining and the inefficiencies of unlined canals. These findings highlight the crucial function of canal lining materials in reducing water loss and increasing irrigation efficiency, emphasizing the need of selecting appropriate lining solutions to improve water conservation in irrigation systems.

Table 1. Seepage losses and conveyance efficiency of PCC lined canal

Year	Discharge in cusecs		Average water losses		Water Loss % age	Conveyance Efficiency (%)
	Q_{in}	Q_{out}	Q_L (cusecs)	Q_L (cumecs)		
2016	4193.217	4101.749	91.468	2.590	2.181	97.819
2017	4078.207	3986.275	91.932	2.603	2.254	97.746
2018	3969.026	3877.569	91.457	2.590	2.304	97.696
2019	3820.233	3735.030	85.202	2.413	2.230	97.770
2020	3664.002	3581.131	82.870	2.347	2.262	97.738
2021	3746.476	3662.410	84.067	2.381	2.244	97.756

Table 2. Seepage losses and conveyance efficiency of brick lined canal

Year	Discharge in cusecs		Average water losses		Water Loss % age	Conveyance Efficiency (%)
	Q_{in}	Q_{out}	Q_L (cusecs)	Q_L (cumecs)		
2016	3984.528	3711.162	273.365	7.741	6.861	93.139
2017	3844.102	3608.372	235.730	6.675	6.132	93.868
2018	3768.952	3550.484	218.468	6.186	5.797	94.203
2019	3580.190	3385.932	194.258	5.501	5.426	94.574
2020	3373.219	3168.412	204.807	5.800	6.072	93.928
2021	3313.045	3115.790	197.256	5.586	5.954	94.046

Table 3. Seepage losses and conveyance efficiency of unlined canal

Year	Discharge in cusecs		Average water losses		Water Loss % age	Conveyance Efficiency (%)
	Q_{in}	Q_{out}	Q_L (cusecs)	Q_L (cumecs)		
2016	1125.530	910.989	214.541	6.075	19.061	80.939
2017	1069.417	865.320	204.098	5.780	19.085	80.915
2018	1031.307	837.957	193.350	5.475	18.748	81.252
2019	1004.731	814.495	190.236	5.387	18.934	81.066
2020	985.592	794.978	190.614	5.398	19.340	80.660
2021	996.399	804.678	191.722	5.429	19.241	80.759

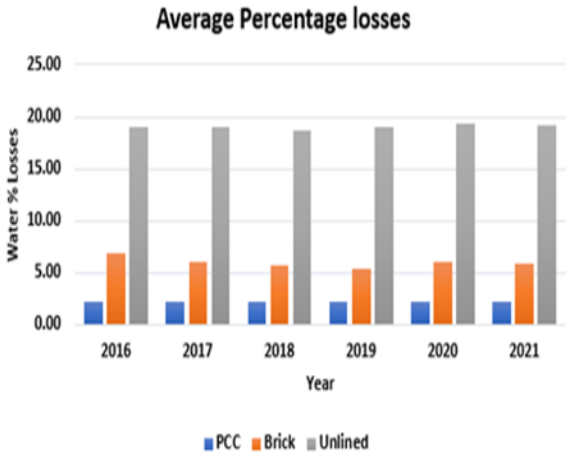

Fig. 3 Comparison of average percentage losses of PCC, brick and unlined canal

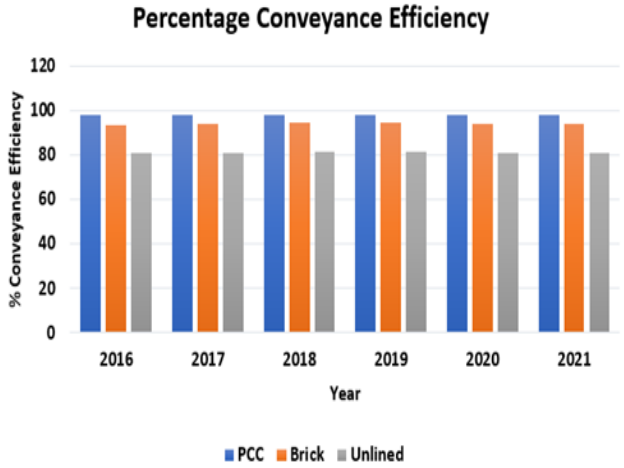

Fig. 4 Comparison percentage of conveyance efficiency of PCC, brick and unlined canal

IV. CONCLUSION

This study determined the seepages losses through Inflow-outflow method in PCC, brick and unlined (Muhajir branch) canals in district Mianwali, as shown in Figure 2. The average seepage losses were evaluated as 2.25% from PCC lined canal, 6.04% from brick and 19.07 from unlined (Muhajir branch). Lack of sufficient maintenance resulted in increased seepage losses. The presence of vegetation, and inappropriate canal alignment, all contribute to the reduced conveyance efficiency in the unlined canal. It

was estimated that PCC and brick lining will reduce the seepage losses by 16.82% and 13.03% respectively.

ACKNOWLEDGMENTS

The authors are thankful to official of Punjab Irrigation Department, Engineer Muhammad Zaheer and NUST Institute of Civil Engineering (NICE) Islamabad, for their kind involvement and assistance in this research project.

REFERENCES

[1] OFWM, (2012). "Punjab Irrigated productivity improvement project." PC-I On Farm Water Management Wing, Punjab".
[2] Syed, N.S.B. et al. (2021) "Analysis of conveyance losses from tertiary irrigation network," Civil Engineering Journal, 7(10), pp. 1731– 1740. Available at: https://doi.org/10.28991/CEJ-2021-03091756.
[3] Shah, Z. et al. (2020) "Analysis of seepage loss from concrete lined irrigation canals in Punjab, Pakistan," Irrigation and Drainage, 69(4), pp. 668–681. Available at: https://doi.org/10.1002/ird.2474.
[4] Lund, A.A.R. et al. (2021) "Field evaluation of a polymer sealant for canal seepage reducation," Agri Water Management
[5] Barkhordari, S. et al. (2020) "Reducing losses in earthen agricultural water conveyance and distribution systems by employing automatic control systems," Computers and Electronics in Agriculture, 168, pp. 105–122. Available at: https://doi.org/ 10.1016/j.compag.2019.105122.
[6] Arshad, M., Ahmad, N., Usman, M., Shabbir, A. (2009). "Comparison of Water Losses between Unlined and Lined Watercourses in Indus Basin of Pakistan." Pakistan Journal Agricultural Science, 46(2).
[7] Zeb, J., S. Ahmad, M. Aslam and Badruddin. (2000). "Evaluation of conveyance losses in three unlined watercourses of the Warsak Gravity Canal." Pak. J. Biological Sciences 3, 352-353
[8] Memon, A. A. (2013). "Design and Evaluation of Dadu Canal Lining for Sustainable Water Saving" Journal of Water Res and Protection, 5,689-698.
[9] Akkuzu, E., Ünal, H.B. and Karatas¸, B.S. (2007) Determination of water conveyance loss in the Menemen open canal irrigation network. Turkish Journal of Agriculture and Forestry, 31(1),11–22.
[10] Sarki A., S. Q. Memon & M. Leghari (2008). Comparison of different methods for computing seepage losses in an earthen watercourse. Agricultura Tropica et Subtropica 41 (4): 197-205.
[11] Singh, V., Raj, C. and Sandilya, S.S. (2021) "Determination of canal seepage loss in Arrah Main Canal: A case study," Irrig and Drainage, 70(5), pp. 1107–1115. Available at: https://doi.org/ 10.1002/IRD.2620.
[12] Mutema, M. and Dhavu, K. (2022) "Review of factors affecting canal water losses based on a meta-analysis of worldwide data," Irrigation and Drainage, 71(3), pp. 559–573. Available at: https:// doi.org/10.1002/IRD.2689.