Comparative Study of Conveyance Through A Canal of Different Linings

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Abstract: **The present study has been conducted to evaluate and compare the conveyance losses in the form of seepage losses in field cum lab study made at the field laboratory of Haryana Irrigation Research and Management Institute Kurukshetra (HIRMI). The water course have been lined with different material i.e. bricks, concrete blocks and plain concrete. The study has been carried out by measuring the reduction in flow rate in different channels. Recourse is the use of Pygmy current meter has been made during the study. It has been found that plain concrete lining is the best while brick lining is the least efficient. In the studies to follow the different types of linings are to be compared based on economics, so that decision making regarding type of lining can be logically done.**

INTRODUCTION

Water is one of the basic requirements for production of crops throughout the world. Besides natural rainfall the water used for irrigation of crops is conveyed through a system of canals through which water may be lost due to seepage and evaporation. Seepage is the process of movement of water from the bed and side of a canal into the soil. The factor that affect seepage from canal include texture of the soil in the canal bed and banks, water temperature changes, siltation conditions, bank storage changes, soil chemicals, water velocity, microbiological activity, irrigation of adjacent fields, and water table fluctuations [4]. The seepage loss in the irrigation canals accounts for the major portion of water conveyance loss (98.37%) [8]. In comparison evaporation loss in irrigation network, being only a small proportion of the overall losses are generally not taken into consideration. Seepage, besides being a major contributor to wastage of water, also leads to other problems such as waterlogging and salinization of agriculture land. Seepage can be reduced considerably by the lining of canals. Lining improves the flowability of water, and conveyance and reduce seepage besides considerably reducing the maintenance cost. A 99% perfect lining would prevent the seepage losses and reduce seepage about 30-40% but it cannot be controlled completely [5]. Significant seepage losses do occur from a canal even if it is lined [7] (Swamee et.al.2000). Hagan [1] found that one-fourth to one-third of all the water diverted for irrigation purposes was lost during conveyance to the field. Khan [6] measured conveyance losses of six watercourses at Pabbi Minor of River Kabul Canal and Sheikh Yousaf Minor of Lower Swat Canal ranging from 27.3 to 42.5 percent. By the time the water reaches the field, more than half of the water supplied at the head of the canal is lost in seepage and evaporation [3].Lining of canal may be constructed with different material like bricks, stone, cement concrete, shotcrete, concrete blocks. Selection of material of lining is a function of durability and economics.

Present work is a report of field study carried out on rectangular water courses. The water courses had been lined with different material. For the present work a comparative study and its analysis thereof, has been done.

The study has been necessitated considering that Haryana, though a small state, contributes considerably to the food grain of country. It has been made possible on account of a well-established and efficient canal network that supplies irrigation water to all parts of the state. Further, owing to the fact that the state which is located very close to the foot hills of Himalayan region offers steep slopes and high velocity in the flow of canals. This necessitates lining of canal. Most of the canals in the state are brick or concrete lined which however gets damaged with time and is not able to maintain its efficiency.

STUDY AREA AND METHODOLOGY

The study areas selected for present work are the field channels of Haryana Irrigation Research Management Institute (HIRMI) at Kurukshetra. The field channels are situated in the research farm of HIRMI on the Kurukshetra-Pehowa highway three km from Kurukshetra. Water in the field channel is made available from a nearby distributary and it runs with the help of motor pump assembly. Total length of channel is 800 feet with a slope of 0.0002 depending upon the different material used for lining total channel has been divided into four equal parts. The materials used for lining are bricks, block type 1, block type 2 and cement concrete. For the measurement of discharge two triangular notches (marked as T.N 1 and T.N 2 in Figure 1) at the entry and exit of water course, five suppressed weir (marked as S.W 1-5) and stilling wells have been installed at specific location throughout the water course as shown in Figure 1.

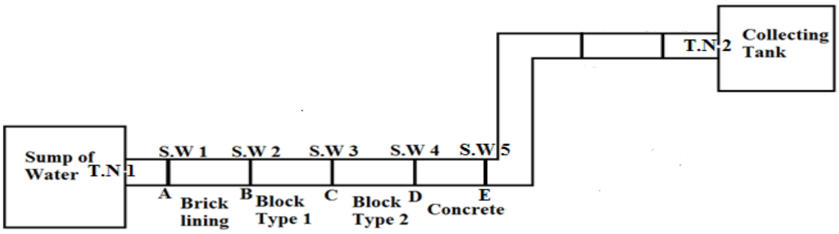


Fig.1: Sketch of field channel of study area

Detail of channels of different linings are shown in Table 1 and photographic view of watercourse in Figure.2 (a, b, c and d).

Table 1: Detail of channels of different linings

Nomenclature	Type of lining from entry to exit	Length Feet (meter)	Width of side wall inch(cm)	Remarks
S1 (AB)	Bricks	200 (60.98)	9 (22.86)	
S2 (BC)	Block type 1 (hollow blocks)	200 (60.98)	8 (20.32)	C : F.A(25% fly ash): C.A 1:2:4
S3 (CD)	Block type 2	200 (60.98)	4 (10.16)	C : F.A(25% fly ash): C.A 1:2:4
S4 (DE)	Concrete	200 (60.98)	8(20.32)	C : F.A : CA 1:2:4

valuation of efficiency of different types of lining has been done with the help of estimation of loss of water through that particular stretch. Though measurement devices like triangular notch and suppressed weir have been installed on the watercourse yet for the present study current meter was employed for the measurement of velocity leading to estimation of discharge.

Fig. 2 (a, b, c, d)

(a) Motor running pump (b) Bricks lining with suppressed weir and stilling well

(c) Concrete lining (d) Triangular notch and sump well

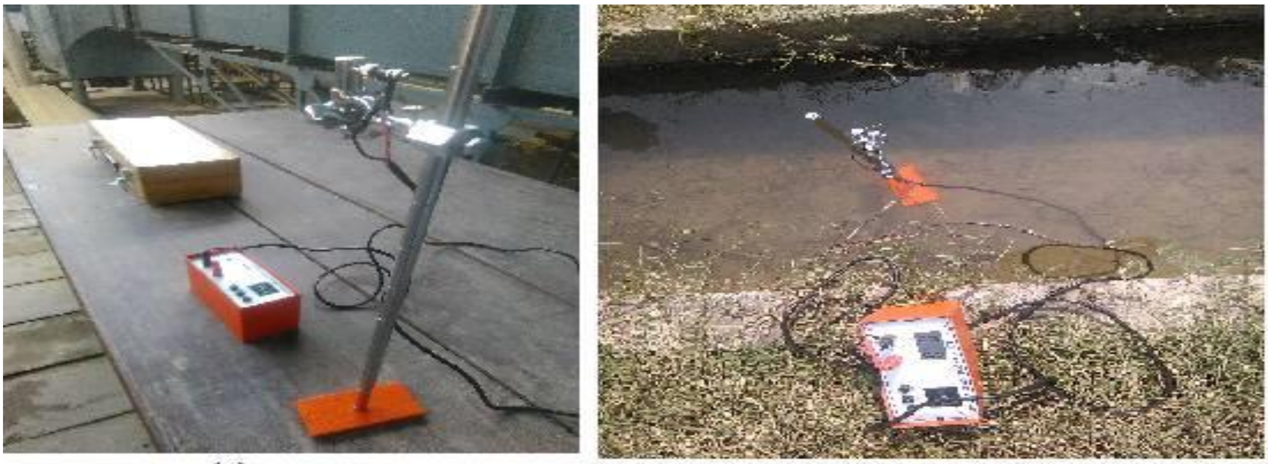
Pygmy water Current Meter is used for stream-flow measurements in shallow streams (Figure 3 b), flumes and small channels, where the velocity of water does not exceed 1m/sec. The principle of operation is based on the proportionality between the velocity of water and the resulting angular velocity of the meter rotor. By placing a current meter at a point in a stream (as shown in Figure 3b) by a Wadding rod and counting the number of revolutions of the rotor during a measured interval of time thus estimating the velocity of water at that point. The governing equation of current meter is

$$v = 0.715RPS + 0.0336 \text{ m/s}$$

v=velocity (m/s)

Q=Discharge (liter/second)

RPS= revolution per second



(a) (b)

Fig. 3(a and b)

(a): current meter setup (battery, wadding rod and battery)

(b): current meter during velocity measurement in field channel

Table 2: Observation with current meter

Location of Current Meter	Depth of Flow (cm)	Width (cm)	Area of Channel (cm^2)	Time (Sec.)	Revolution
Entry(Suppressed Weir 1)	21.3	58	1235.4	20	3
	21.3	58	1235.4	40	7
	21.3	58	1235.4	60	10
Suppressed Weir 2 (End of Brick Lining Starting of Block Type 1)	19.3	56	1080.8	20	3
	19.3	56	1080.8	40	8
	19.3	56	1080.8	60	10
Suppressed Weir 3 (End of Block Type 1 Starting of Block Type 2)	17	58	986.0	20	3
	17	58	986.0	40	8
	17	58	986.0	60	11
Suppressed Weir 4 (End of Block Type 2 Starting of Concrete Lining)	16.3	58	945.4	20	3
	16.3	58	945.4	40	7
	16.3	58	945.4	60	10
Suppressed Weir 5 (End of Concrete Lining)	15.3	58	887.4	20	3
	15.3	58	887.4	40	7
	15.3	58	887.4	60	10

Table 3: Detailed Estimation of Seepage Losses

Stretch	RPS (Rvl. /sec.)	Current meter velocity (m/sec.)	Manning's Velocity (m/sec.)	Current meter discharge (Q_c) (m^3/s)	Avg. Q_c (m^3/s)	Manning's discharge (Q_m) (m^3/s)	Avg. Q_m (m^3/s)	Seepage losses (m^3/sec.)	Seepage losses (m^3/sec.)
	0.15	0.141	0.232933	0.017419		0.028776			
Entry	0.175	0.159	0.232933	0.019643	0.018655	0.028776	0.028776		
	0.166	0.153	0.232933	0.018902		0.028776			
								.006283	0.00168598
	0.15	0.141	0.208112	0.015239		0.022493			
S1	0.2	0.177	0.208112	0.01913	0.016969	0.022493	0.022493		
	0.166	0.153	0.208112	0.016536		0.022493			
								0.002829	0.001126827
	0.15	0.141	0.199429	0.013903		0.019664			
S2	0.2	0.177	0.199429	0.017452	0.015842	0.019664	0.019664		
	0.165	0.164	0.199429	0.01617		0.019664			
								0.002232	0.001566193
	0.15	0.141	0.184384	0.01333		0.017432			
S3	0.175	0.159	0.184384	0.015032	0.014276	0.017432	0.017432		
	0.166	0.153	0.184384	0.014465		0.017432			
								0.001511	0.0008758
	0.15	0.141	0.179414	0.012512		0.015921			
S4	0.175	0.159	0.179414	0.01411	0.0134	0.015921	0.015921		
	0.166	0.153	0.179414	0.013577		0.015921			

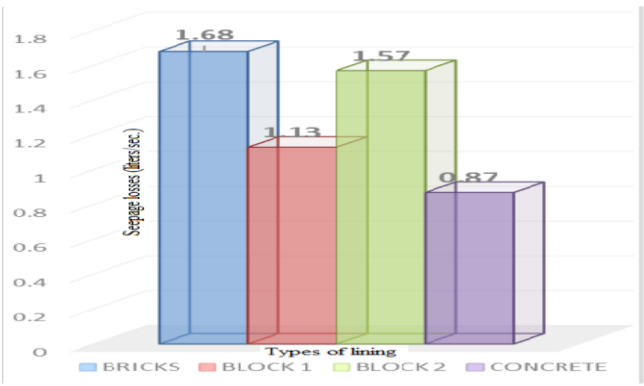


Fig.4: Comparison of seepage losses liters/sec. (lps) using current meter

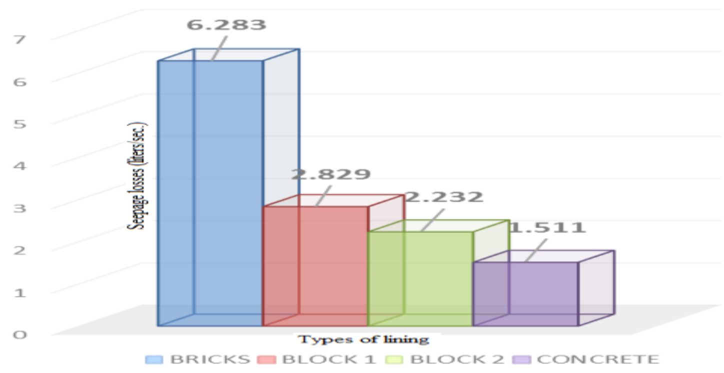


Fig.5: Comparison of seepage losses liters/sec. (lps) using manning's formula

For velocity measurements readings at entry have been taken for current meter placed at commencing of stretch comprising of brick lining. Similarly all other readings in S1, S2, S3 and S4 have been preserved through the observation Table 2. Manning's coefficient used for calculation of manning's velocity is 0.015, 0.016 and 0.017 [2] for comparatively bricks, blocks and concrete linings, respectively.

ANALYSIS AND DISCUSSION

Table 2 readings are taken by current meter placed at different locations. In Table 3 it has been observed that discharges using current meter are 18.655 lps, 16.969 lps, 15.842 lps, 14.276 lps and 13.4 lps at SW1, SW2, SW3, SW3, SW4 and SW5 location respectively as shown in Figure1. Therefore the seepage losses in different stretches S1, S2, S3 and S4 are respectively 1.68 lps, 1.12 lps, 1.56 lps and 0.87 lps as shown in Figure 4 using current meter. As compared by manning's formula the discharges has been observed at SW1, SW2, SW3, SW3, SW4 and SW5 are 28.776 lps, 22.493 lps, 19.664 lps, 17.432 lps and

15.921 lps respectively. Therefore seepage losses in different stretches S1, S2, S3 and S4 are 6.283 lps, 2.829 lps, 2.332 lps, 1.511 lps by applying manning's formula as shown in Figure 5.

Therefore from above analysis it is concluded that seepage losses are minimum in S4 and are 48.21%, 22.79% and 44.44% less as compared to S2, S3 and S4 stretch respectively, using current meter. Similarly applying manning's formula the seepage losses are minimum in S4 and are 75.95%, 46.58% and 35.20% as compared to S2, S3 and S4, respectively.

CONCLUSIONS AND RECOMMENDATIONS

The Seepage losses of different linings are computed by current meter at different sections along the total length of watercourse as well as by manning's formula. In this study mainly focus is on that type of lining which have minimum seepage losses. According to experimental study using current meter, plain concrete lining is more suitable than the brick, block type 1and block type 2 lining. From economical point of view cost analysis of all these linings is required because cost is also a major factor during canal construction. Therefore in further study we will take cost analysis as well as seepage losses so that we will be able to compare out of bricks, block type1, block type 2 and concrete lining which is more economical.

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