Water Losses in Canal Networking (Narmada Canal Section Near Gandhinagar-Ahmedabad)

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Abstract

Canal is used for supply water to one place to another place. In canal, different types of losses occur. Seepage and Evaporation are the serious problems of water loss in an irrigation canal network. The losses from canals need to be minimized to ensure the efficient performance and effective utilization of water [2]. From depth below of the ground surface as the seepage losses can possible in canal. But there are numbers of methods to know about the determine seepage losses. Seepage loss is main problem in unlined canal. In lined canal, seepage loss reduces maximum. In this paper Analysis of the seepage losses in lined canal networking at a section canal and for the maximum discharge of lined canal.
Keywords: Seepage loss, lined canal, inflow-outflow method

I. Introduction (Water losses in canal)

Canal system designed and constructed transports water from the source like River to the farmer’s fields. But it has to take care about canal water supply with a minimum amount of water loss. Water losses can seriously reduce the efficiency of water delivery to fields. Water may be lost by seepage, leakage, or both. The canal water tries to seep into the soil. Moreover the canals are exposed to the atmosphere at the surface. The water also goes to the atmosphere in the form of vapour. The losses in irrigation canals are mainly, (1) Evaporation losses, (2) Absorption losses, (3) Percolation (seepage) losses, (4) Transpiration losses.

A. Seepage losses:

When water table is close to the ground surface a direct flow from the channel to the ground water reservoir occurs & there is a zone of continuous saturation from the channel to the water table or water table decreases due to absorption [1]. The loss due to seepage is the one which is most significant so far as irrigation water loss from a canal is concerned. Providing perfect lining can prevent seepage loss from canals but cracks in lining develop due to several reasons and performance of canal lining deteriorates with time [3].

B. Evaporation (Percolation) Losses:

It is the transfer of the water from the liquid to vapour stage. As the canal water is exposed to the atmosphere at the surface, loss due to evaporation is obvious. It is of course true that in most of the cases evaporation loss is not significant. It is may range from 0.25 to 1 % of the total canal discharge [1].

The loss of water due to seepage and evaporation from irrigation canals constitutes a substantial part of the usable water. 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 [4]. Seepage loss is the major and the most important part of the total water loss [5]. Seepage and evaporation are the serious problems of water loss in an irrigation canal network

II. Study Area

The Narmada Main Canal is 458 km Long. The Main Canal passes through 9 districts and 27 talukas of Gujarat. The main canal is the largest concrete lined canal in the world having capacity of 1134 m3/s at head. The capacity of main canal is tapering down to 72 cumec at Gujarat- Rajasthan border. The selection of main canal at the head is 73.10m* 7.50m at the tail is 10.3m*4.4m. The construction of Narmada main canal was carried out in phase manner.

- PHASE 1: Ch. 0 to 144.500 km

- PHASE 2: Ch.144.500 to 263.265 km
- PHASE 3: Ch. 2630265 to 458.00 km

Narmada canal is the main canal. Also it is the perennial canal. It is the trapezoidal & also lined canal. In this canal for the construction PCC is used. The grade of PCC is M15. The side slope of the canal is 2:1. & the foundation of the canal is raft foundation. The thickness of the raft is 10 cm thick. The approximate canal width is 250 m. In this canal river bed is at higher from the bed level of the canal bed. The normal depth of flow is 6 to 7 m.

In this paper of water losses of canal networking, study area is Narmada Main Canal near Gandhinagar & Ahmedabad. Which is in the phase 2 where the Narmada canal is passing through KARAI and JASPUR [Which is (229.920 TO 246.477) km starting of canal].

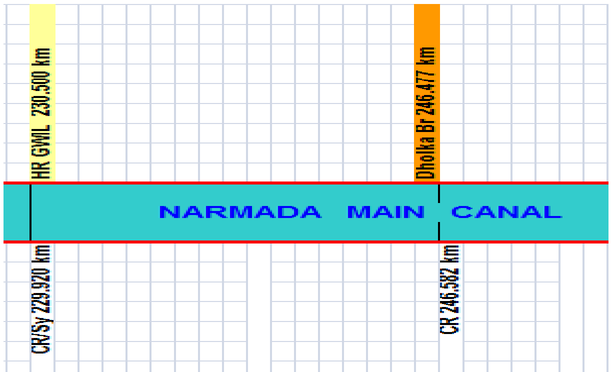

Fig. 1: The line diagram of NMC

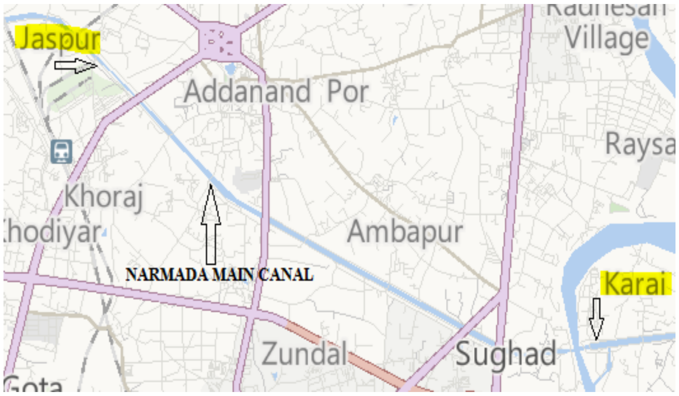

Fig. 2: Karai to Jaspur NMC Map

Table – 1
(Data Source: N.W.R. W.S & K. Department, Government of Gujarat. And Canal in-charge, Sabarmati syphon, Karai)

Description	
Bed width	*67.50 m*
Full supply level	*64.77 m*
Side Slope	*2:1*
Discharge Capacity	*881.634 cumecs*
Free board	*1.50 m*
Bed level D/S	*57.46 m*
Full supply depth	*7.30 m*

III. METHODOLOGY

This section discusses methods for estimation of seepage water losses.

A. Inflow-outflow method.

1) Analytical Method (Is: 9447~1980) [6]:

The seepage losses from unlined canals can be calculated by analytical methods or determined by direct measurements on the channels. The analytical calculations of seepage losses based on coefficient of hydraulic conductivity of soil and the boundary conditions of the flow system are of particular value for the canals which are in the planning stage. The method of direct measurement of seepage losses is applicable to the existing canals.

The seepage 10SWS from unlined canals depend on the canal dimension, the permeability of the subsoil, distance of governing drainages and the difference in the water levels of canal and the drainage. Initial seepage losses are high due to steep gradient, but as the subsoil becomes saturated the gradients flatten and ultimately stabilize.
Analytical solutions are available for evaluating seepage losses from canals under steady conditions for the following cases.
The solutions given here are for homogeneous and isotropic medium.
The flow is assumed to @ laminar and hence follows Darcy's law.

1) Canals located in medium extending up to infinite depth with shallow water table;
2) Canals located in medium extending up to finite depth with shallow water table; and
3) Canals located in medium extending up to infinite depth with deep water table.

In order to assess the seepage losses and the profile of water table on either side of the canal, following data should be collected:

1) Bed width of canal;
2) Water depth inside the canal at full supply;
3) Side slope of the canal;
4) Distance of the governing drainages on either sides of the canals;
5) Dry season and rainy season water level of drains on either side;
6) Coefficient of permeability of the subsoil: The value of coefficient of permeability would be determined in field by a suitable method such as pumping out test; and
7) Profile of the subsoil to find out if any effective impermeable layer exists and its depth.

The drainages at which the above information shall be collected shall depend upon the order of variations in its values of above parameters. Where variation in the subsoil permeability, the drainage distance and the difference in the water levels of the canal and drain is large, the data should be collected at a spacing of 2 km. Otherwise it may be collected at 5 to 10 km spacing.

Canals Located in Medium Extending Up to Infinite Depth with Deep Water Table - The solution for this boundary condition was obtained by Vedernikov with the help of conformal mapping. The seepage discharge, q per unit length of channel is given by:

$$q = k\{B + (A + 2m)H\}$$
$$= k(B_s + AH)$$

Where B = Bed width of channel; Bs, = Surface width of channel; H =water depth inside channel; and A is function of geometry of canal, the value of A is obtained from Data of NMC for the known values of B/H or Bs/H and m, where m = cot □ □ and □ □= side slope angle.

2) Limitations of Analytical Method:

The drainage conditions on either side of the canal are assumed to be symmetrical and in practice may be different. The seepage losses and phreatic surface for both the sides are determined separately assuming that the dividing line is vertical through the centre of the canal.

B. Field Study Method

It is very simple method. It consists in measuring the quantity of water entering a certain reach & the quantity of water going out of that reach. The difference gives the amount of water lost. The discharge can be measure by flums, weirs, current meters or venturimetres. It is necessary to maintain constant water level allowance should be waiting for evaporation loss also.

The inflow-outflow method consists of performing both upstream and downstream discharge measurements and compares the values obtained in those canal sections.

The main advantage of this approach is represented by the fact that the losses are measured under the normal operating conditions of the canal.

The major disadvantages of this method are the need for a large number of very accurate measurements over time and the impossibility to identify localized losses. The inflow-outflow method is a water balance approach that consists in the direct measurement of the flow rate flowing into and out of a reach of canal.

The layout structure of the field analysis of inflow – outflow method of seepage loss in a canal network is as follow:-

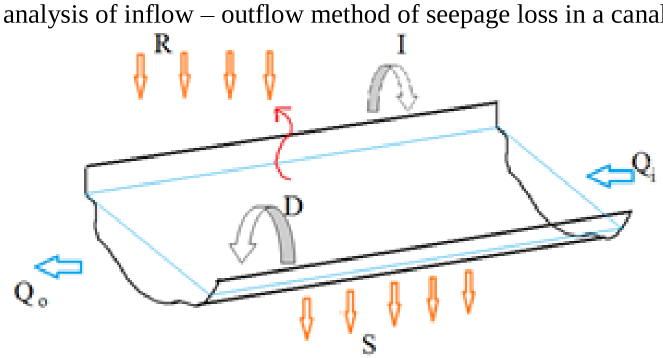

Fig. 3: Reach of the canal showing Inflows and Outflows [7]

S = Qi - Qo- D + I - E/ (P*L)
Where, S= seepage loss rate;
Qi= upstream inflow rate;
Qo= downstream out flow rate;
D= flow diverted along the reach;
I= inflow along the reach;
P=wetted perimeter
L=length of channel reach (length of canal syphon)
E = evaporation. To use this method it is necessary to assume steady flow conditions and take long canal reaches to obtain a measurable loss [8]

IV. CALCULATIONS

A. Inflow-Outflow Method On Field:

Data [9]:
Data are referred from the design discharge, depth of water from canal bed, design velocity & utilization of Narmada water through Narmada main canal
Qi= (discharge*velocity/height of water per second)
=927.37*1.478/7.30=187.87 cumec
Qo=881.63*1.4711/7.30=177.66 cumec
D=345 cusec= 9.76 cumec
I=881.63 cumecs
E= 1% of 881.63 cumecs (assuming) = 8.816 cumecs
P=b+2y (1+z^2) ^ (1/2) = 90.10m
Where b=57.46m, y=7.30m, z (side slope) =2:1
L=614m
Therefore,
S=187.87-177.66-8.816-9.76+881.63/ (90.10*614)
=0.015785 cumec
Therefore, Seepage loss is very less in main canal section with respect to other small canals (branch canal, minor canal).

V. DRAWBACKS OF NARMADA MAIN CANAL

In the Narmada main canal there is some water losses. And these water losses can possible as;
1) Algae: Owing to water storage for some time, there is increasing problem of algae in canal.
2) Public pollutions: Some wastes are thrown in canal by people.

VI. CONCLUSION

The study is to know seepage loss in Narmada Main Canal. There is very less seepage loss at karai to jaspur canal section in NMC. NMC is lined canal so there is less chance for seepage loss. But the other drawback at that section like increasing algae at side slopes of canal. Maintenance of the canal section is not easy because it is perennial canal.

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