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Optimal Utilization Of Irrigation Water: A Case Study On Nashik Left Bank Canal [nlbc], Nashik

KEYWORDS: Closed Conduit Irrigation [CCI], Conveyance losse, Economy, Nashik Left Bank Canal.

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ABSTRACT The present paper is based on the Case Study of Nashik Left Bank Canal [NLBC] of Nashik district, Maharashtra state. The reach of this canal is 64 km which is running open to atmosphere through the alluvial type of soil. The objective of this paper is to use the closed circular conduits for the entire 64 km reach of canal in place of open canal irrigation [OCI] network to minimize the conveyance losses. The 15.55 Mm3 of the water within the stretch of 64 km can be saved by using CCI for NLBC. The benefit-cost ratio as calculated for CCI system over OCI is 3.18 which is greater than 1; therefore CCI system can be thought for the implementation so as to optimally utilize the irrigation water.

I. INTRODUCTION

Open canals are used to convey the water from storage reservoir to the agricultural land for irrigation. Water has to travel from its head to fulfill the needs of agriculture; irrigation channels with poor maintenance causes heavy losses during its conveyance phase. It is observed that the losses due to evaporation, infiltration, percolation and water thefts in open canal reduce the efficiency and yield of irrigation. Therefore it is necessary to check these conveyance losses in case of irrigation canals. The main objective of this paper is to convert existing open canal system of NLBC into CCI network to minimize the conveyance losses which are 56% for NLBC's open canal network.

II. CASE STUDY OF NLBC

Nashik district of Maharashtra state is one of the leading districts in the field of agriculture. Nashik District is also known as Grape City as Grape being the main crop of Nashik. Gangapur Dam is most important and the oldest Earthen dam in Nashik. It was constructed in 1965 on Godavari River of Gangawadi. Two canals namely Gangapur Right Bank Canal [GRBC] and Nashik Left Bank Canal [NLBC] take off from the dam. The GRBC is closed due to high Civilization in the area. The present paper is based on the case study of Nashik Left Bank Canal of Nashik district, Maharashtra state. The reach of this canal is 64 km which is running open to atmosphere through the alluvial type of soil. The Designed discharge of NLBC is 8.92 cumec which irrigates 1573.22 Ha and 1287.22 Ha of land in Rabi and Hot Weather season respectively.

1) Command area of NLBC

The command area of NLBC is shown in fig. 1. The blue print of NLBC's command area is obtained from Nashik Irrigation Department

Fig.1. Command Area of NLBC
Source: Nashik Irrigation Department

2) Canal Outlet

The details of canal outlet are given in Table I. Information given in Table I is obtained from the Annual Water Account of Major and Medium Projects, NID (June 2013)

TABLE I
CANAL OUTLET FOR NLBC

Sr. No.	Description	Data
1	Size	2.44 m X 2.44 m
2	Canal Bed Level [CBL]	589.94 m
3	Designed Discharge	8.92 cumec
4	Chainage [Location]	801.83 m
5	Bed Width	4.57 m
6	Bed Gradient	1:4000
7	Length	64 km
8	Full Supply Depth [FSD]	1.65 m
9	Type	Unlined

Source: Annual Water Account of Major and Medium Projects, NID (June 2013).

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3) Crop Pattern and Crop Water Requirement

Table II deals with the crop pattern and crop water requirement details of NLBC. NLBC runs mainly for 2 seasons i.e. Rabi and Hot Weather. 27.491 Mm3 of water is required by NLBC for the area of 2860.44 Ha. This water requirement is converted into cumec which comes out to be 2.21 cumec.

TABLE II
CROP PATTERN AND CROP WATER REQUIREMENT DETAILS FOR NLBC

Season	Crop Pattern	Area [Ha]	Water Requirement Mm^3	Cumec
Rabi	Grapes	965.10	6.76	0.64
	Sugarcane	137.04	4.701	0.12
	Vegetables	86.02	1.28	0.10
	Wheat	81.03	0.888	0.07
	Others	304.03	5.132	0.14
Hot	Grapes	1125.07	7.88	0.95
Weather	Sugarcane	162.15	0.85	0.19
		ΣA= 2860.44	ΣW= 27.491	ΣQ=2.21

Source: Annual Water Account of Major and Medium Projects, NID (June 2013).

4) Conveyance Losses of NLBC

In Table III, the existing conveyance losses are calculated by the quantity of water supplied at the head and quantity of water used for irrigation.

TABLE III
DETAILS OF LOSSES OF NLBC

Sr. No.	Season	Area under Crop [Ha]	No. of Days of water	Water supplied at head [Mm^3]	Water used [Mm^3]	Conveyance Losses Mm^3	%
1	Yearly	2860.44	72	27.55	12.00	15.55	56
2	Rabi [15 October – 28 February]	1573.22	54	18.761	8.073	10.69	57
3	Hot Weather [1 March-30 June]	1287.22	18	8.793	3.931	4.862	55

Source: Annual Water Account of Major and Medium Projects, NID (June 2013).

5) Diameter of Closed Conduit for NLBC

It is clear from the above tables that even after fulfilling the water demands, the net water available at the tail end is much less than that of the head, this indicates huge conveyance losses. In the entire length of NLBC these conveyance losses are mainly due to seepage through canal sides and bottom as NLBC is unlined, evaporation through canal top surface of width 5m, and water thefts from canal contributes as a major part of losses. The seepage and evaporation losses are observed in the entire reach of NLBC. It is also observed from the results that, these losses are 57% in Rabi wherein 55% in hot weather season. This supports the need of converting open channels into closed conduit flow. From the study of crop water requirement and existing crop pattern, it was observed that for a Base Period of 72 days, the total water demand is 27.55 Mm3. Therefore, actual discharge [Qactual] required in NLBC can be found by multiplying Designed Discharge of 8.92 cumec with Efficiency [Ƞ] i. e.43.57%. The conduit diameter is evaluated from the relation of actual discharge with area and velocity. Chezy's formula is used for the velocity of flow with the value of C taken as 140. The diameter of equivalent conduit section required to be provided to the NLBC is 1.82m.The conduit required to be used for irrigation is required to be durable and strong. Hence, for the NLBC's Closed Conduit Irrigation, Glass Fiber Reinforced Pipe [GRP] will be used. The C-value of GRP is 140 wherein for NLBC it is 40.

6) Froude Number and Losses of NLBC for conduit flow

The freeboard taken for the CCI of NLBC is 0.5m. The diameter of conduit is 1.82m and freeboard is 0.5m, therefore full supply depth available in CCI is 1.32m.The velocity of flow and Froude number for OCI of NLBC is 0.7456m/s and 0.3058 respectively. For CCI of NLBC the velocity of flow and Froude number available will be 1.493m/s and 0.4149 respectively. As for CCI Froude number is less than 1 which indicates subcritical flow, therefore it is safe to have CCI for NLBC. The discharge that will be available in conduit for the velocity of 1.493m/s and full supply depth of 1.32m is 1.583 cumec. Considering major and minor losses available in conduit, the head lost in GRP ϕ1.82m as calculated is 3.02m.

7) Economy of Closed Conduit Irrigation [CCI] over Open Canal Irrigation [OCI]

The capital cost that will be required for Closed Conduit Irrigation [CCI] of NLBC has been found out by an approximate estimate. The details of the capital cost are given in Table IV.

TABLE IV
ECONOMY OF CCI FOR NLBC

Sr. No.	Description	Cost [Rs.]
1	Total cost of 12m long 5333 GRP of ϕ1.82m	1,31,19,18,000
2	Total cost of 5406 sleepers	23,6,67,468
3	Total Labour Cost for Laying GRP	22, 33,800
4	Total Transportation Cost	13, 35,000
5	Total Machine Cost	36, 00,000
6	Contractor's Profit	134,27,54,26.8
The Capital Required for CCI of NLBC = Rs. 147, 70, 29,695		

8)Cost Recovery Analysis of Closed Conduit Irrigation [CCI] over Open Canal Irrigation [OCI]

Every year NLBC requires the maintenance of about Rs. 1 0000000.The CCI minimizes the conveyance loss of 27.55 Mm3, which can be used to irrigate extra irrigable land which comes under the command area of NLBC.

TABLE V
DETAILS OF IMPROVEMENT OF IRRIAGATED AREA AND REVENUES

Sr. No.	Season	Extra Land That can be Irrigated	Yield Per Ha in Tonns	Total Production	Rate / Unit	Agricultural Output [Rs]
1	Rabi	2083.2 Ha	25	52080	850	4,42,68,000
2	Hot Weather	1592.08 Ha	25	39802	850	3,38,31,700

Source: Annual Water Account of Major and Medium Projects, NID (June 2013)

Therefore,
Extra Revenues per Year

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= Extra Revenues / year for Rabi Season + Extra Revenues / year for Hot Weather Season
= Rs. 7, 80, 99,700
Profit in 1 Year by adopting CCI for NLBC
= Maintenance amount of Open Canal Irrigation of NLBC + Extra Revenues generated per year
= Rs. 8, 80, 99, 700
The working life of GRP is 70 years. The Number of Years required for accumulation of the Capital Cost for GRP 1.82m is 16 years and 9 months i.e. 16.76 years.
An amount of Benefit generated in 53.24 years
= Rs. 469, 04, 28,028
Therefore, Cost-Benefit Ratio for CCI of NLBC = Profit Generated by CCI / Capital Cost of CCI =Rs. 469, 04, 28,028/ Rs. 147, 70, 29,695=3.1756 ≈ 3.18.

9) Advantages of Closed Conduit Irrigation [CCI] over Open Canal Irrigation [OCI]

Beside improved water use efficiency, other benefits of Closed Conduit Irrigation [CCI] can be listed as below:

a. For NLBC, closed conduit will be laid in an already existing canal; this will reduce the land acquisition cost.

b. NLBC needs maintenance cost nearly to 1 crore rupees yearly wherein complete CCI needs complete maintenance of about 5% of the Capital Cost (Kolhe, 2012).

c. As CCI increases the Duty of water by 2.29 cumec and 3.31 cumec for Rabi and Hot Weather Season, therefore more area can be brought under irrigation for NLBC.

d. Conveyance losses have resulted into decreased efficiency of canal ranging from 57% in Rabi & 55% in Hot Weather Season. Hence, the use of CCI will save 15.55 Mm3 of water, thus increasing the efficiency of NLBC.

e. Additional Revenues can be generated to the Irrigation Department as water thefts and losses will be minimized using CCI. 338 lakhs and 442 lakhs of additional revenues will be generated for Hot Weather and Rabi Season due to checking of losses using CCI.

f. NLBC sites have problems like Breeding of mosquitos, Fly Nuisance, Water Logging and Salinity which all can be minimized if CCI system is implemented.

g. CCI is suitable for murum type of soil stratum which covers most of the part of NLBC.

h. The amount of revenues generated will be increased as proper metering of water will be done using CCI system. The flumes constructed on NLBC is failing to do the proper metering of water utilization, therefore using CCI this task can be achieved.

I. As calculated in cost recovery analysis of closed conduit irrigation [CCI] over Open Canal Irrigation [OCI], the cost – benefit ratio is 3.18 i.e. greater than 1. Therefore, this system can be thought for the implementation of CCI in place of OCI.

j. NLBC OCI works on rotation basis whereas CCI can be implemented as Continuous Uninterrupted Irrigation Water Supply system.

k. Using CCI, there will be equal distribution of water from Head to Tail. Therefore conflicts related to Irrigation Water Distribution will be resolved to huge extent.

10) Limitations of Closed Conduit Irrigation [CCI]

a. CCI needs great care in Design and Construction.

b. CCI will need Silt Extractors at its head to avoid the silt entry into the system.

c. This is a modern system, due care has to be taken in India for its smooth functioning.

I. CONCLUSION

It is revealed from the hydraulic analysis part, that the conversion of open canal into circular closed conduit is technically feasible and there is impact of water saving of 10.69 Mm3 for Rabi Season and 4.862 Mm3 for Hot Weather Season for improving irrigation potential by reducing the conveyance losses. A case study of Nashik Left Bank Canal [NLBC] of length 64 km shows that 57% losses during Rabi season and 55% of conveyance losses during Hot Weather can be stopped by adopting this system. Thus, the net saving of 15.55 Mm3 can be achieved by adopting CCI. The Capital Cost of such conversion is justified on the basis of water saving of 15.55 Mm3 and increased irrigation potential of 2083.2 ha and 1592.08 Ha for Rabi and Hot Weather Season respectively. The maintenance cost of CCI is negligible as compared to OCI. The additional revenues of 780 lakhs will be generated after the proper functioning of CCI system which will be helpful for recovering the capital incurred for installation of the system. The cost-benefit ratio of CCI for NLBC is 3.18. Therefore this indicates that the CCI for NLBC is technically feasible. Hence, it is recommended to use CCI in place OCI to save the valuable water.

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