

Improving Irrigation Efficiency: Lining of Canals A Case Study of Rajasthan Feeder and Sirhind Feeder Canal	
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ABSTRACT Lining of canals is an important method to improve efficiency in irrigation sector. A case study of lining of two parallel canals, Rajasthan Feeder (capacity 18500 cusecs) and Sirhind Feeder (capacity 5272 cusecs), off taking from Harike Headworks(Pb) is presented here. Various issues involved in the lining of such important canals carrying considerable discharge have been discussed e.g. lining of canals having common bank, minimal closure time, Geo-synthetics etc. MoWR and CWC were required to device various design issues involved in the lining of these two important canals. An expert team comprising designers and material testing personnel together with Project Officers worked out different alternatives and implementation strategies. Many important observations were made during the deliberations of this expert team which are of interest to the planners and designers of water conveyance systems, Main issues involved herein revolve around very short time available for repairs and introduction of Geo-synthetic material for lining. There may be similar situations elsewhere and experience gathered here may be of substantial assistance in other projects.	

1. INTRODUCTION

Substantial amount of water is wasted through seepage from Irrigation canals. The loss of water by seepage from unlined canals in India varies from 0.3 to 7 m³/s/10⁶ m² depending on the permeability of soil through which the canal passes, location of water table, distance of drainage, bed width, side slope and water depth in the canal. In addition, flow velocity, soil and water temperature, atmospheric pressure and stratification of underlying soil also affect the seepage rate.

Sometimes the water lost through seepage is helpful in replenishing the ground water but on many occasions, this precious water is not just lost but also causes water logging. Lining of canal is a prominent method of reducing seepage losses from canals. But when canal lining gets damaged, the loss through lining becomes substantial which may approach the loss through an unlined canal. Under such circumstances it becomes imperative to repair / reline the damaged canal lining. However, planning of repair / relining of large canals entail many challenges, some of which are mentioned here by considering a case study of Relining of Rajasthan Feeder and Sirhind Feeder.

2. PROJECT BACKGROUND

Rajasthan Feeder and Sirhind Feeder offtake from Harike Head Works constructed downstream of confluence of the Sutlej and Beas rivers. The Bhakra Dam on Satluj and Pong Dam on Beas are situated upstream of Harike Head works. Rajasthan Feeder with 18500 cusecs capacity is exclusively meant for providing water to Indira Gandhi Nahar Project serving the command lying in the territory of Rajasthan State and is life line of Western Rajasthan. Seven districts of Western Rajasthan are totally dependent on it for drinking water. Major cities like Jodhpur, Bikaner, Jaisalmer, a number of towns &

cities along with major Army cantonments situated along the canal are dependent on it for drinking water. Besides it also supplies water to Power Plants at Suratgarh, Ram Garh etc. Sirhind feeder is also an important feeder canal off taking from Harike Headworks with 5264 cusecs capacity and having command area in Punjab.

Rajasthan Feeder and Sirhind Feeder run parallel with common bank. Salient features of these canals are given below:

Table 1 Salient Features of Canals

S. No	Parameter (largest Value in entire canal length)	Rajasthan Feeder	Sirhind Feeder
1	Discharge (Cusecs)	18500	5264
2	Bed Width (ft)	125	41
3	Depth (ft)	21	16.2
4	Side slope (Horizontal : Vertical)	1.5 : 1	1.25 : 1
5	Free Board (ft)	2.5	2.5
6	Length of canal to be lined (km)	97	100
7	Top Width (ft)	208.2	99.13

These two canals were taken up for construction in 50's and were completed in 60's. Both the feeders were constructed as lined channels with single brick lining on bed and double brick lining on side slopes. These canals have been running continuously for past 50 years (app.) Only minor maintenance of these canals has been carried out with the result that these canals has deteriorated over the year causing seepage to the extent of about $3.81 \text{ m}^3/\text{s}/10^6 \text{ m}^2$ which is much more than normally expected from lined canals.

It is reported that when these canals were constructed, the ground water table was at a considerable depth from surface. Over the years this water table has risen and in some areas it has reached almost surface level. Central Ground Water Board in its report on Water logging in Mukatsar Areas has observed that seepage from canals is one of the factors causing water logging in this area. Further Ground water is saline and is unfit for irrigation. Therefore, conjunctive use of Ground Water for Irrigation is not feasible.

Proposals for relining of Rajasthan Feeder (RD 179000 to 496000 i.e. appox. 97 km) at an estimated cost of 952.10 crore and relining of Sirhind Feeder (RD 119700 to RD 447927 i.e. appox. 100 km) at an estimated cost of 489.165 crore were accepted by Technical Advisory Committee of Ministry of Water Resources in its 98th meeting held on 9.7.2009.

3. OBSERVATIONS AND RECOMMENDATIONS

Central Water Commission was involved in this project from DPR stage. Advice was provided to Project Authorities on various accounts through active consultations. Project areas were also visited by a team of CWC Officers along with officers of concerned State Governments from 18th to 19th November 2009. An expert group (henceforth referred to as 'Group') was also convened under the Chairmanship of Member (D & R), CWC involving designers from CWC, CSMRS and representatives from Irrigation Departments of Punjab and Rajasthan to provide assistance for finalizing design provisions of the Project. Many important issues regarding the project including as well as those which were deliberated in the proceedings of the group are as follows:

I. High Ground Water Table

One of main problem in relining was high ground water table of the area. Since these two canals are running parallel with a common bank, seepage was also a major concern. As the relining operation requires dry base and seepage may endanger the slope stability of side slopes, it was imperative to lower the ground water table. This problem was pointed out to Project authorities at the DPR scrutiny stage. It was suggested to Project Authorities that three rows of bore holes may be provided in DPR. It was further suggested that at the time of construction stage planning, monitoring of ground water table may be done in the vicinity of work area and suitable measures of bank stabilization, if required, may be taken.

II. Limited Closure Time

As mentioned above, these canals are catering for drinking water for a number of townships and villages in several Districts, besides its usage for Thermal power generation and for meeting the irrigation requirements (during specified periods). Therefore careful planning was required to avoid hardship to water users especially in Rajasthan. It was informed that Rajasthan Canal system has a storage capacity of 21 days and irrigation water requirement is minimum during the period from March to May.

The Chief Engineer, Govt. of Punjab proposed to provide about 50 % of the minimum water requirement of Rajasthan through Sirhind feeder (or Rajasthan feeder as the case may be) and the remaining through Bikaner Canal via Gang Canal Link Channel off-taking from Rajasthan Feeder and linking Bikaner Canal. After detailed discussions, it was concurred by both the States that drinking water requirement of Rajasthan including thermal power requirement and losses etc. will be 2650 cusecs which need to be ensured by Punjab at the Rajasthan Border and that the minimum continuous working period for relining of both Rajasthan feeder and Sirhind feeder during the year will be 60 days starting from 20th March to 20th May each year. The Government of Punjab agreed to complete the work in four years. However, the Punjab Govt. shall make efforts to reduce the execution period, provided adequate funds are made available to match with the construction schedule. It was also decided that in order to prepare the contingency plan, a joint meeting may be convened by BBMB with Party States namely Rajasthan, Punjab and Haryana for exploring the alternative arrangement of drinking water etc. through Bhakra Main Branch and the decision so arrived informed to CWC.

It was recommended by the Group that while executing the projects, concerns of Rajasthan need be sufficiently taken care of in order to ward off any hardship to the State of Rajasthan. For this purpose, a joint committee, comprising representatives from both Punjab and Rajasthan be set up to ensure uninterrupted water supply of agreed quantity to Rajasthan during the implementation phase of the project.

III. Under Water Lining

Taking into account the issue of high ground water table and limited closure time, it was opined that possibility of lining the canals under flowing water condition may also be explored. In this context two case studies were consulted namely: i. Installation of underwater Geomembrane and concrete lining in the Coachella Canal in Southern California during 1991 as a small pilot project (Fred p. Rohe, 2004), ii. lining of Kakrapar Canal, Gujarat (D. J. Ketkar, P. A. Bakshi, 1988) . However, these two case studies were for canals of much smaller size than Sirhind Feeder and Rajasthan Feeder and as such could not be adopted for the present project.

IV. Use of Fibre Reinforced Concrete

The issue of using Fibre Reinforced Concrete for lining was deliberated in the Group. It was observed that fibre reinforced concrete having better crack resistance properties and better erosion resistance may be considered for canal lining. Two types of fibre reinforced concrete were considered:

- a. Plastic Fibre Reinforced Concrete
- b. Steel Fibre Reinforced Concrete

Relevant information / material pertaining to the use of fibre reinforcement (Plastic and Steel) was presented for the consideration of group by the Punjab Irrigation Department. It was observed that data presented for use of plastic fibre reinforced concrete as canal lining does not cover its long term effects in contact of water, long term toxicity effects and possibility of loose detached fibres in canal water which is to be used for drinking purpose. Further it was also observed that there are not many instances of FRC for use as canal lining. Therefore it was suggested that instead of FRC, use of PPC or Slag cement with suitable admixtures may be considered for controlling the cracks in lining. It was also opined that the available concrete ingredients may be got tested in for suitable mix design with

the required dose of admixtures for control of cracks. In this regard it was also observed that due attention may be given to choice of curing compound considering the temperature variation in the field.

V. Use of Geo-Composite Filter

The issue of using Geo-Composite filter below canal lining in place of conventional sand filter was also deliberated in the Group. It was felt that adoption of Geo-Composite filter may shorten the time required for lining operation. It was observed that Geo-Composite filter should be suitable for the base material. As recommended by the Group, soil samples were got tested by Govt. of Punjab for various properties and based on the results obtained, range of properties required in Geo-Composite was decided. Various geo-composite manufacturers were requested for technical design / proposals and in response, 3 manufacturers namely Garware-Wall Ropes, Techfab India and Maccaferri provided their design / proposal. It was decided that pilot reaches would be taken up and that Govt. of Punjab would correspond with these agencies for obtaining proposals for taking up pilot reaches, identify the pilot reaches to be given to the above three agencies, provide all the necessary support to the agencies in getting the work in pilot reach completed and tested at the earliest. The Govt. of Punjab would thereafter provide their report / views to the Group on the performance of the work carried out.

4. CONCLUSIONS

Many of our canal systems are in urgent need of repairs. Most of them have issues like high ground water table, short closure period etc. which were encountered in the above case study. Such cases require careful planning and implementation strategies. It is hoped that above case study shall be of assistance in such cases.

5. ACKNOWLEDGEMENT

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Photograph 1. Damaged lining of Rajasthan Feeder



Photograph 2. Water Logged area of Rajasthan Feeder