

## 22.1 Lining the Canals

It is always assumed that seepage losses would be reduced from the theoretical calculations as between 3.7-1.8 cumec per million square metres (cumec/Mm<sup>2</sup>) for an unlined canal in the sandy or clayey loams to 0.6 cumec/Mm<sup>2</sup> for a lined canal. In 1988 a field study of the performance of lined distributaries were losing 3.5 cumec/Mm<sup>2</sup> and watercourses were losing 3.7 cumec / Mm<sup>2</sup>.

Why is there such a gap between assumptions at the feasibility stage and what happens in practice?

Old earthen irrigation channels in permeable soils can lose a lot of water through seepage. Large losses through the bed and sides of canal lead to low conveyance efficiency; that is, (the ratio of water reaching farm turnouts to that released at the source of supply from a river or reservoir). Earthen canals also get clogged up with weeds which reduce the water-carrying capacity.

These two factors combine to disadvantage of the tail end farmers. Therefore Unlined canals are inefficient, inadequate from the point of view of equitable performance.

In Punjab, the expected saving by brick lining is of the order of 20% . The brick linings have 25 years of life.

Total losses from unlined watercourses are known to be more than those from the main system, but they dont get the same attention during a lining programme. Lining programmes are divided into main system lining and watercourse lining. The main system canals (main, distributaries, and minors) are large channels supplying several watercourses.

A typical value for the seepage rate in an unlined channel in clayey loam is 1.8 m<sup>3</sup>/s per M m<sup>2</sup> and through a rendered brick line water course or canal reduces to 0.1 m<sup>3</sup>/s per M m<sup>2</sup>. However, if the impervious canal lining has few crack what would happen? The experiments indicate it as good as that of the original unlined case when the ground water level is high.

Inspite of the above observation, lining can significantly reduce conveyance losses. Lined channels have a smaller surface area for a given discharge than unlined

channels. Typically a lined channel will have 40% of the unlined surface area for a given discharge. Therefore even at the same loss rate per unit area there will be a saving in water. When estimating the reduction in losses from a lining programme, this should be based on the combination of a reduced cross-section and a reduced seepage rate per unit area.

In the Indian Punjab, measurements on lined distributaries and watercourses between four months and seven years old showed that seepage rates from the distributaries rapidly became comparable to seepage rates from unlined canals, whilst seepage rates from watercourses were highly variable.

Lining of the distributary canal seemed to have had a beneficial effect on the equity of supply between watercourses. However, the effects of lining watercourses is still to be established.

A sample of 15 out of 130 watercourses were tested on the 30,000 ha Mudki subsystem of the Sirhind Feeder in Ferozpur district using ponding tests and inflow-outflow methods. The mean and variability of seepage losses increased dramatically for lining more than four years old. Some lining older than four years performed as well as new linings, with losses as low as  $0.4 \text{ m}^3/\text{s}$  per  $\text{Mm}^2$  but others has losses of up to  $11.5 \text{ m}^3/\text{s}$  per  $\text{Mm}^2$ . Overall conveyance losses were significantly greater than seepage losses alone.

The variability of conveyance losses was observed to be related to the condition of the channels. Losses from raised watercourses with cracked or broken linings appeared as surface leakage causing waterlogging of adjacent fields and localised crop damage. This was due to poor quality control during construction, particularly earth compaction behind sidewalls, and a lack of subsequent maintenance.

The design life of concrete and brick lined channels is generally assumed to be 25-50 years. Major repairs of lined channels are sometimes required within a few years of construction. At the Kraseio Scheme in Thailand, completed in 1981, long lengths of the concrete lined main canals have needed to be replaced each year.

In one 26-year lining test, a complete repair of the drained test channel was required every 22 months.

There is no watertight case for or against lining.

If lining goes ahead, a high standard of construction is essential, especially of water courses which must withstand a great deal of wear and tear. Without adequate supervision, poor construction of channels will lead to reduce life and higher maintenance costs.

Earthen watercourse in the Bikaner area of Rajasthan discharge an average 28.3 l/s, but begin to seep and leak badly after little more than a year. These cracks and the slow movement of shallow water favours development of thick aquatic weeds, which encourages the drying and the cracking process, and structurally weaken the banks. This obviously adds significantly to the cost of maintenance.

The cracks opened in dry periods do not close fully when saturated by water flows, and losses can be up to 25% of the water diverted into the system.

The cycle of swelling, heaving, shrinkage and settlement leads to progressive bank deterioration. Shear strength of clays depends on cohesion between particles. In a newly-formed compacted clay masses the interparticle cohesion is high. On first drying, the cracks appear and close up again on wetting, but do not regain their original interparticle cohesion. This means a reduction in shear strength after a few drying and wetting cycles.

The reinforced concrete lining would reduce the seepage loss drastically and has lower operation and maintenance costs.

## Reference

World Water, April 1989, pp 16, 19, 21.

Appendix (i)

Table - 1 Salient Aspects of Seepage through Lined Canals [7]:

Sl.No	State	Adopted practice
1	U.P. Practice	$Q_l = 1/200(B + D)^{2/3}$
		$Q_l$ = Seepage losses in cumecs/km length B and D are bed width and depth.
2	Punjab & Haryana	$K_l = 1.9Q^{1/6}$
		$K_l$ = Seepage loss in cumecs / $10^6$ sq.mof wetted area.
		Q = Main discharge in the canal.

3	Bhakra Nangal	Lined canal $K_l = 1.25Q^{0.056}$ (F.P.S)
		Unlined canal $q_l = 0.00928Q^{0.5265}$ (M.K.S)
4	Andhra Pradesh	lined canal: $Q_l = 0.60$ cumecs / $10^6 m^2$ of wetted surface
		Unlined canal: $Q_l = 1.85$ to $2.40$ cumecs / $10^6 m^2$ of wetted surface and 20% extra for distributory system.
5	CBIP	Main canal - 7% of head discharge
		Distributory and minors - 8% of head discharge
		Water surface - 20% of head discharge

Table-2 Salient Aspects of Seepage through Lined Canals (After Yu. M. Kosichenko [8]):

Sl. No.	Type of lining and character of disturbance	Permeability $K_l$ m/s	seepage loss $Q$ m <sup>3</sup> /sec/m <sup>2</sup>
I	Concrete-film lining		
	i. Smooth	$0.705 * 10^{-9} / 0.141 * 10^{-7}$	$0.334 * 10^{-4} / 0.685 * 10^{-5}$
	ii. Crack with rough walls	$0.652 * 10^{-9} / 0.136 * 10^{-7}$	$0.318 * 10^{-6} / 0.665 * 10^{-5}$
	iii. Silted cracks	$0.137 * 10^{-9} / 0.156 * 10^{-7}$	$0.318 * 10^{-8} / 0.76 * 10^{-7}$
	iv. Without cracks	$0.590 * 10^{-11} / 0.114 * 10^{-9}$	$0.228 * 10^{-8} / 0.556 * 10^{-7}$
II	Concrete lining		
	i. Smooth	$0.225 * 10^{-8} / 0.331 * 10^{-6}$	$1.243 * 10^{-6} / 1.516 * 10^{-4}$
	ii. Crack with rough walls	$0.867 * 10^{-9} / 0.202 * 10^{-6}$	$0.423 * 10^{-6} / 0.982 * 10^{-4}$
	iii. Silted cracks	$0.706 * 10^{-10} / 0.752 * 10^{-10}$	$0.344 * 10^{-7} / 0.367 * 10^{-7}$
	iv. Without cracks	$0.694 * 10^{-10}$	$0.388 * 10^{-7}$
III	Soil film lining		
	i. Protective layer of local soils	$0.981 * 10^{-9} / 0.189 * 10^{-7}$	$0.564 * 10^{-7} / 1.087 * 10^{-6}$
	ii. Protective layer of compacted clay	$0.221 * 10^{-11} / 0.425 * 10^{-10}$	$0.127 * 10^{-9} / 0.245 * 10^{-8}$
IV	Soil Membrane	$1 * 10^{-8}$	$0.575 * 10^{-6}$
V	Unlined channel	-	$0.295 * 10^{-3}$

## Plastics as a lining material

### Introduction

Water suitable for human consumption, livestock and irrigation is limited in many parts of the world. Since precipitation is the only source of all fresh water and since it varies from place to place, from year to year and from season to season, water must be collected, stored and transported, if it is to be available when and where it is required. The loss of irrigation water in a canal system occurs during its conveyance through canal, sub-canal, distributory, minor, water course and finally during application in the

field. In a study made by the Central Water and Power Commission (1967), the losses during the various phases of water conveyance was found to be as shown in Table

Water use efficiency in percentage						
System Characteristics	Number of		Water courses	Field Losses	Total Loss	Net Utilization
	Canals	Distributaries				
Entire system unlined.	15	7	22	27	71	29
Only Canal lined.	4	7	25	30	66	34
Canal and Distributary lined.	4	2	26	32	64	32
Whole system lined.	4	2	6	42	54	46

It may be observed that, in a completely unlined canal irrigation system the loss of irrigation water is as much as 71%. This loss is attributed to both evaporation and seepage losses; evaporation losses are a function of temperature, humidity and wind velocity. It is not practicable to prevent evaporation loss (in some reservoirs this loss has been prevented by floating a thin PE film on the water surface) in running water. However, seepage losses could be effectively minimised by the use of an impervious medium between the porous soil and the water flowing in the system.

Conventional materials like clay, tiles, cement-concrete, have been used for prevention of seepage losses. Most of the conventional methods are either too expensive or not very effective.

Table 2 shows the state wise break-up of irrigation resources and the length of major irrigation canals operating in each state.

Irrigation and Power Research Institute at Amristar has particularly conducted intensive research in this field and a suitable lining technique has been evolved for existing earthen canals and channels.

This technique is known as "Combination Lining" and in this, a low cost Polyethylene film is laid at the bed of the canal or distributary whereas the sides are lined with pre cast brick-tile blocks. This method can be conveniently adopted for lining distributaries during short closures. This technique has many advantages over the other methods of lining such as laying new lined parallel channels which involve construction of new

























