

Chapter 6

Canal lining

6.1 INTRODUCTION

Should a canal be lined? This question is often asked by farmers or those engaged in the operation of irrigation schemes. Some relevant considerations are discussed in this chapter, including:

- the necessity for lining,
- selecting the type of lining, and
- implementing the lining.

See also the publication by D.B. Kraatz, *Irrigation Canal Lining*, (published by FAO in 1973) which considers these subjects in detail.

6.2 ADVANTAGES AND COSTS OF LINING

Before the decision is made to line a canal, the costs and benefits of lining have to be compared. By lining the canal, the velocity of the flow can increase because of the smooth canal surface. For example, with the same canal bed slope and with the same canal size, the flow velocity in a lined canal can be 1.5 to 2 times that in an unlined canal, which means that the canal cross-section in the lined canal can be smaller to deliver the same discharge.

Possible benefits of lining a canal include:

- water conservation;
- no seepage of water into adjacent land or roads;
- reduced canal dimensions; and
- reduced maintenance.

6.2.1 Water conservation

An important reason for lining a canal can be the reduction in water losses, as water losses in unlined irrigation canals can be high. Canals that carry from 30 to 150 l/s can lose 10 to 15% of this flow by seepage and water consumption by weeds.

Lining a canal will not completely eliminate these losses, but roughly 60 to 80% of the water that is lost in unlined irrigation canals can be saved by a hard-surface lining.

Minimizing water losses is very important, and especially so in schemes where irrigation water is pumped. Reduced water losses means less water to pump and thus a reduction in pumping costs.

6.2.2 No seepage of water to adjacent land or roads

If canal banks are highly permeable, the seepage of water will cause very wet or waterlogged conditions, or even standing water on adjacent fields or roads. Lining of such a canal can solve this problem, since the permeability of a lined canal bank is far less than that of an unlined bank, or may even be zero, depending on the lining material.

6.2.3 Reduced canal dimensions

The roughness - resistance to flow - of a lined canal is less than that of an unlined canal, and thus the flow velocity will be higher in the lined canal when the canal bed slope is the same. Moreover, the hard surface of the lining material allows a higher velocity compared to an earthen canal surface as it is not so easily eroded. As discussed earlier, canal discharge is the product of the cross-section of a canal and the velocity of the flow. Therefore, with the higher velocity allowable and obtainable in lined canals, the canal cross-section for a lined canal can be smaller than that of an unlined canal.

6.2.4 Reduced maintenance

A surface lining, such as concrete, brick or plastic, on the canal prevents the growth of plants and discourages hole-making by rats or termites, and so the maintenance of a lined canal can be easier and quicker than that of an unlined canal. Moreover, the higher velocity that can safely be allowed in the lined canal prevents the small particles of soil carried in the water from settling out, accumulating and causing siltation.

The bed and sides of lined canals are more stable than those of unlined canals and are thus less susceptible to erosion.

6.2.5 Costs of lining

The costs of lining can be very high, depending on the local cost of lining material and of labour, as well as on the length of canal to be lined. Prices of lining material vary from place to place. Irrigation committees and farmers who are considering lining the canals in their irrigation scheme should gather information on prices of material and of the labour required.

6.3 SELECTING THE TYPE OF LINING

The most commonly used types of lining are shown in Figure 40, and include:

- concrete;
- concrete blocks, bricks or stone masonry;
- sand cement;
- plastic; and
- compacted clay.

The choice of lining material depends primarily on:

- local costs;
- availability of materials; and
- availability of local skills (local craftsmen).

If cement, gravel and sand are relatively cheap and locally available, concrete lining is generally a good choice. Although the initial investment in concrete lining is generally high, if it is properly constructed and maintained it could last for many years, which thus offsets the high initial cost.

If a local fired brick industry produces cheap bricks or if construction stone or precast concrete slabs are locally available, brick or stone masonry or a concrete slab can be considered. Large amounts of cement are required for mortar and plastering. The construction of this type of lining requires more labour than other methods, thus its use tends to be limited to where labour is abundant and the material cost is relatively low.

If a sufficient volume of heavy clay is available near the irrigation scheme, a clay lining could be considered. Lining canals with clay is rather labour intensive, and so the costs of labour should be taken into account when comparing costs and benefits. The use of clay can reduce seepage losses and improve the smoothness of the canal surface, but does not stop weed growth and possible erosion.

If coarse aggregates are not available and cement is relatively cheap, soil (sand) cement lining could be considered.

6.4 IMPLEMENTATION

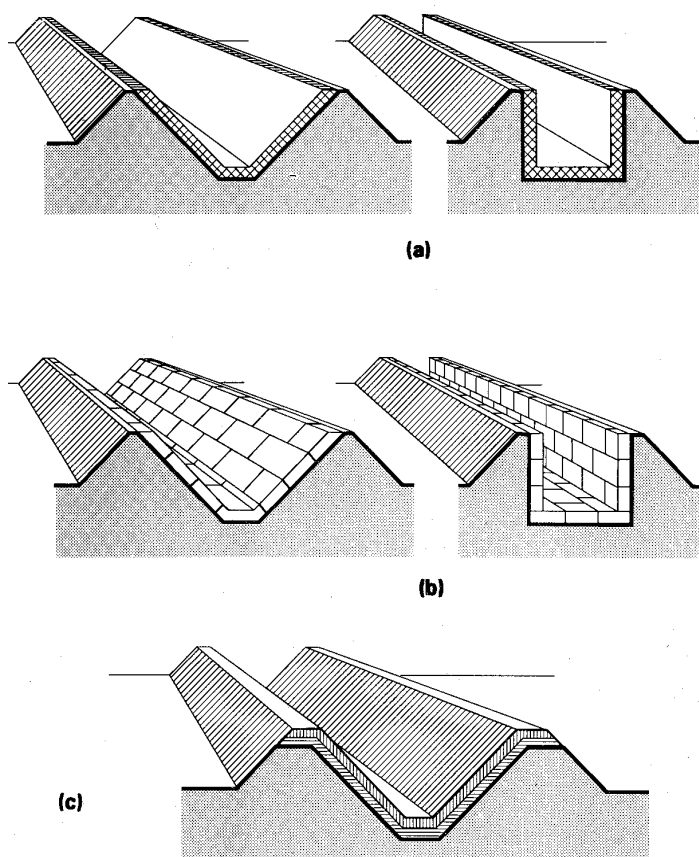
6.4.1 Preparation

Construction of a canal lining begins with the earthworks. The canal is usually constructed in earth except for where concrete flumes or pedestals on or above the ground are needed.

To save lining material and to facilitate forming, the soil subgrade should be excavated and compacted to the exact shape, grade and alignment of the canal.

FIGURE 40

Different types of lining: (a) concrete lining; (b) masonry lining; (c) compacted clay or soil (sand) cement lining



Careful attention must be paid to the foundation of any canal lining, especially when fills are involved. The fill should be carefully made, compacted when moist and wetted prior to placement of lining material.

Linings for rectangular canals are generally done on flat ground. First the bottom section is constructed, and then the vertical sides are added, which will be supported by an earth bank backfill, as shown in Figures 40 and 44-D.

6.4.2 Concrete lining

Concrete lining can be placed in many ways, including:

- hand placing by plastering on sides and bed (Figure 41);
- using forms and pouring alternate panels (Figure 42); and
- using prefabricated concrete elements (Figure 43).

FIGURE 41
Hand plastered canal lining



When the concrete lining is hand placed, attention has to be paid to the concrete mix. The concrete must not be very fluid to avoid it creeping downward from the sides. On steep side slopes, formwork is necessary to hold the concrete in place until it sets.

When the lining is placed using the alternate panel method, guide forms are used. Sections are poured alternately, with the finished sections being used as forms for the sections in between.

Small openings or expansion joints spaced at intervals of 1.5 to 3 m are needed for the expansion and contraction of non-reinforced concrete. These joints are filled with flexible, asphaltic material to prevent water leakage.

For small canals, prefabricated concrete elements can also be used, such as the units shown in Figure 43, although the prefabricated elements in Figure 43 are provided with gates.

FIGURE 42-A
Installation of guide forms



FIGURE 42-B
Pouring the concrete



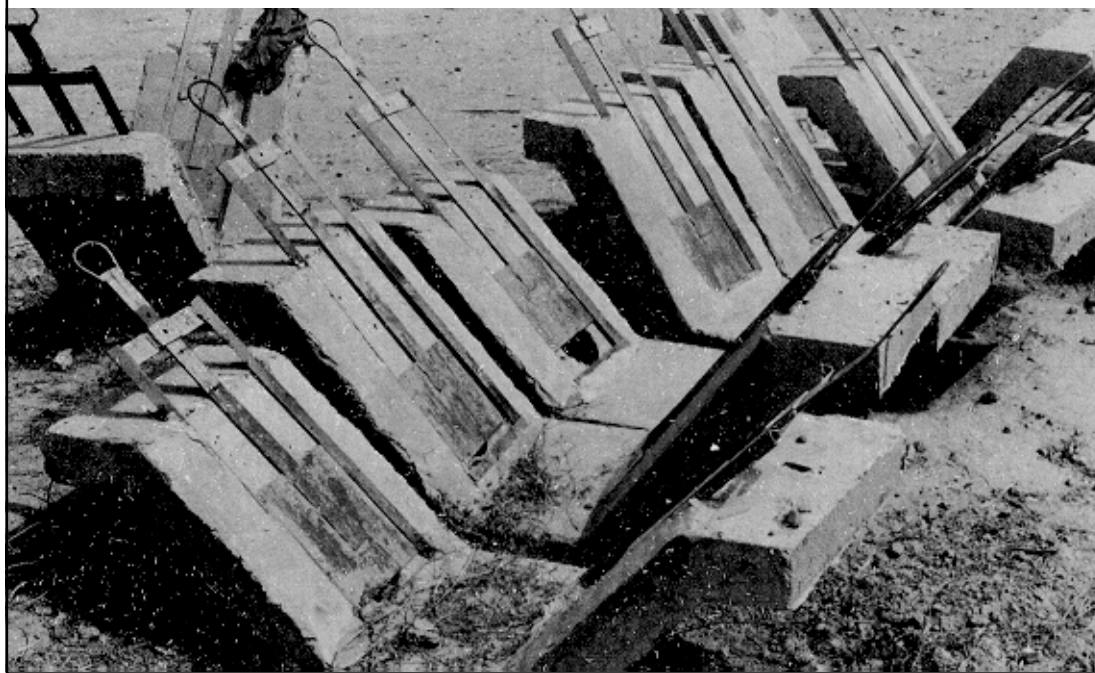
FIGURE 42-C
Compacting, forming and smoothing with a screed



FIGURE 42-D
Alternately lined canal sections



FIGURE 43
Prefabricated concrete canal elements



6.4.3 Concrete block, brick or stone masonry lining

The concrete blocks, bricks or stones are laid flat on the compacted sides and bed of the trapezoidal canal. The joints are filled with cement mortar, which should have a cement-to-sand ratio of 1:3 to 1:4 (one part of cement to 3-4 parts sand, by volume).

A rectangular canal can be constructed with a concrete or masonry bed and vertical masonry walls. See Figures 44-A to 44-D.

Figure 44-A shows the destruction of the old unlined canal bed. The foundation for the concrete block lining is in preparation. The block in the foreground will be used as a reference level.

The blocks in Figure 44-C need to be plastered. Usually the water side of the masonry structure is plastered, particularly if the bricks are not of good quality.

6.4.4 Compacted clay or plastic lining

One of the oldest methods for reducing seepage losses and improving canals is to remove the porous earth and replace it with clay material. The clay is moistened and placed in layers on the bed and sides of the canal. Each layer should be compacted.

Canals can also be lined with plastic or asphalt. These materials can be covered with earth or gravel to protect them from weathering and mechanical damage. However weed growth and soil erosion could continue on such cover. See Figure 45.

FIGURE 44-A
Destroying the old canal bed



FIGURE 44-B
Laying the concrete block floor

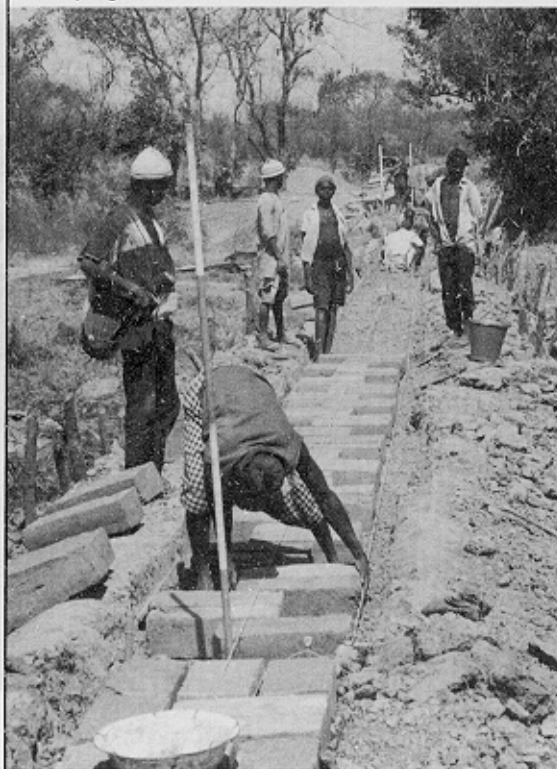


FIGURE 44-C
Making the walls



FIGURE 44-D
Earthen support banks are added

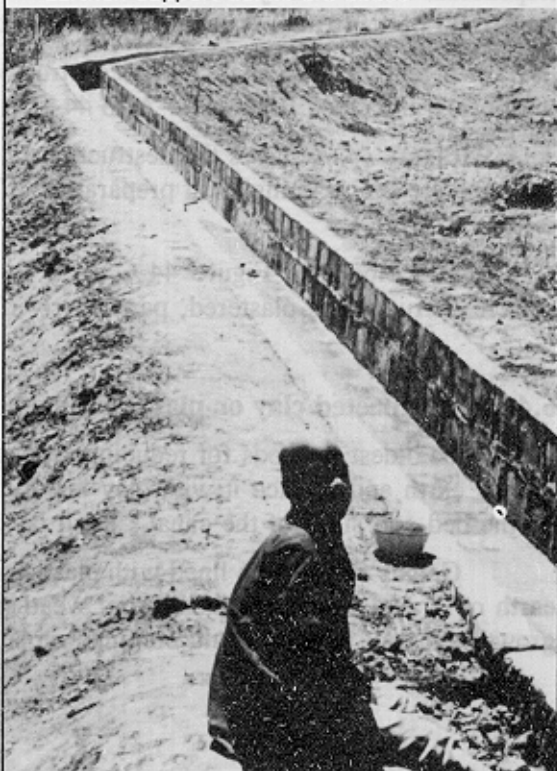


FIGURE 45
Plastic lining



The plastic lining in Figure 45 is easy to install. Such a flexible lining is useful in soils that contain swelling clays or gypsum. However, plastic linings are easily damaged by vegetation, machines, people or animals. When exposed to strong sunshine over prolonged periods, the plastic may disintegrate.

