Chapter 5

Maintenance and repair works

5.1 INTRODUCTION

This chapter describes why and how a canal system should be maintained. The chapter also looks at some of the most important repair works in connection with canals.

The performance of an irrigation canal system depends not only on how the system is operated, but also on the condition of the canals. Irrigation canals function well so long as they are kept clean and if they are not leaking. If no attention is paid to the canal system, plants may grow and the problem of siltation may arise. Even worse, the canals may suffer from leakages.

Plant growth and sedimentation not only impede the flow in a canal, they also diminish the area of the cross-section. As a consequence, the canal capacity may diminish (see Section 3.3). A reduction in the capacity may result in overtopping and a limit on water supply to the fields. The available water will also be reduced when there are leakages in a canal. To protect the system from these problems, the canals should be maintained on a regular basis.

It is not just the smaller, tertiary irrigation canals that need to be maintained, it is the primary and secondary canals as well. Sometimes these canals may be located far from the farmers' fields and this can be one reason why farmers show no interest in maintaining them. However, the smaller canals receive water from these canals and so maintenance of the larger canals is of vital importance for the proper functioning of the whole system.

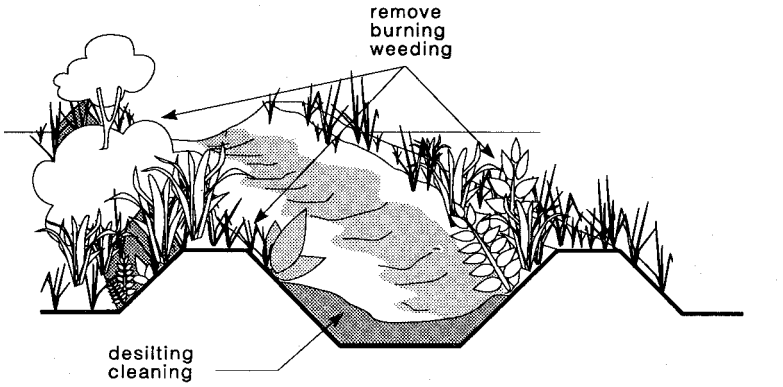
Even when a canal is well maintained, serious technical problems may arise. These problems need to be solved by repair or improvement works. A repair should usually be done as soon as possible, depending on the severity of the problem. Improvements, such as the lining of a canal section, may be postponed until the end of an irrigation season, when canals are dry and farmers have more time available.

After a serious problem is found on an inspection tour, a team of workers or farmers should be available for repair as soon as possible. Such a team should be formed at the beginning of the irrigation season in order to have it on call in case of emergencies. The same team may be asked to do the improvement works. If necessary, a contractor may be asked to do the job.

5.2 CANAL MAINTENANCE

A good maintenance programme can prolong the life of canals. A routine, thorough programme should be kept to. Maintenance of an irrigation canal system is usually carried out in between two irrigation seasons, or at times of low water demand. It consists of cleaning, weeding, de-silting, re-shaping, and executing minor repairs.

FIGURE 29
Weeding, cleaning and de-silting



- Bushes or trees on canal embankments should be removed. They may obstruct the water flow and their roots will open the compacted soil in the banks and cause the development of leakages.
- Plants, silt and debris in the canal should be removed. While cleaning the canal bed, care must be taken that the original shape of the cross-section is kept. For this, a wooden frame, or template, with the exact dimensions of the designed cross-section of the canal being cleaned, can be of great help (see Section 5.6.1).
- Breaches and rat holes in the embankments should be filled with compacted soil, inside as well as outside of the embankment. For compacting, the soil should be wetted.
- Weak sections and sections of canal embankments where people or animals cross the canal should be strengthened with compacted soil or with bricks.
- Eroded sections of a canal should be rebuilt to the original shape.

See also Figures 29 and 30.

For maintenance operations it is important to organize farmers and to involve them in the activities. See Figure 31.

5.3 REDUCTION OF SEEPAGE LOSSES

Parts of a canal bank or the entire bank can be highly permeable to water. Water that seeps through the banks will be lost for irrigation and may create waterlogging in the fields and roads adjacent to the canal.

There are two ways to overcome seepage problems, either

- reduce the permeability of the canal bank, or
- line the canal.

The second solution, lining, will be described in Chapter 6.

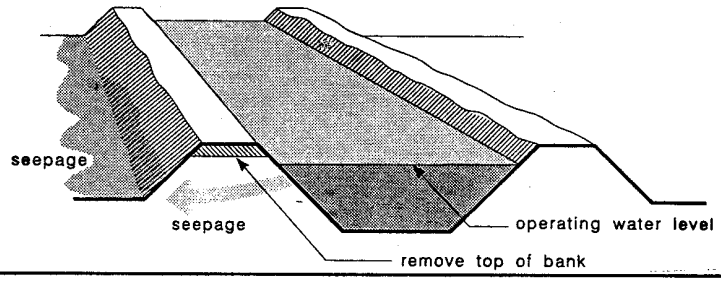
FIGURE 30
Fully covered canal bed

FIGURE 31
Canal maintenance

Reducing the permeability of a canal bank

The permeability of a canal bank can be reduced by compacting the centre, or core of the embankment. The core is first excavated by digging a narrow trench, and then replaced with soil in layers, compacting each layer. The compacted core should extend above the water level.

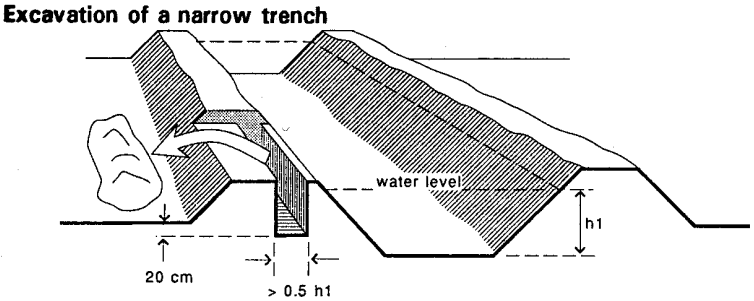
FIGURE 32-A
Preparation for core compaction



The procedure is:

Step 1 Remove the vegetation on the canal bank and the top of the bank. (Figure 32-A)

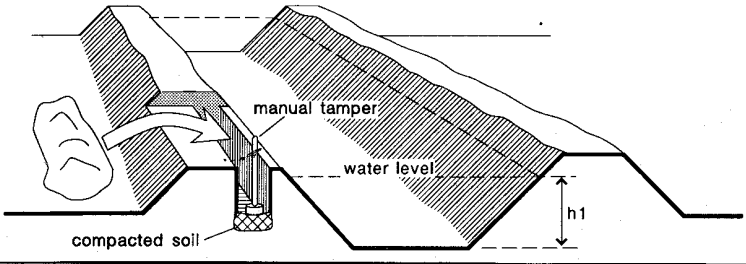
FIGURE 32-B
Excavation of a narrow trench



Step 2 Excavate a narrow trench near the inner side of the canal bank.

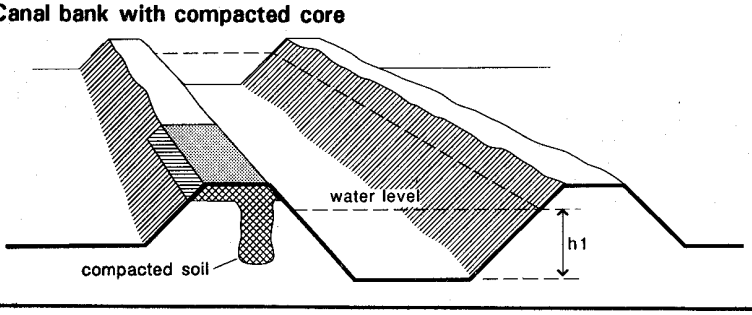
A trench is excavated in the permeable section of the canal. The width of the trench is at least 0.5 x the water depth in the canal. The bottom of the trench should be some 20 cm below the original ground surface elevation (Figure 32-B)

FIGURE 32-C
Refilling the trench and compacting each layer



Step 3 Compact the bottom of the trench with a manual tamper and replace the soil in layers of about 5 to 10 cm each. The soil should be moist when being compacted.

FIGURE 32-D
Canal bank with compacted core



When the excavated material is rather

sandy, the core should be filled with other material which contains more clay. Each layer is wetted and the wetted soil is then compacted. Wetting the soil is conditional for good compaction, since the aggregates in soil that is moist will disintegrate by tamping, while those in dry soil will not. (Figure 32-C)

Step 4 Fill and compact the trench until the top is reached. (Figure 32-D)

5.4 REPAIR OF A LEAK

Most irrigation canals will leak.

A hole or a crack in the bank of a canal, through which water is leaking, is easily observed since the fields adjacent to the leaking canal will be wet. A hole or a crack in the bed of a canal is difficult to see, unless the canal is dry and the bed is inspected very carefully.

Leaks should be repaired immediately after they have been observed.

The procedure for repairing a leak is:

Step 1 Empty the canal and indicate the location of leakage with pegs. They are placed at its entrance in the canal bed and at its exit in the outer bank.

Step 2 Remove the vegetation and keep it apart. Excavate the canal bank to well below and besides the leak. The canal bank which leaks is excavated in steps, with the smallest step well below the leak. (Figure 33-B)

Step 3 Rebuild the canal bank by filling the bank in layers with moist soil, and compact each layer well. (Figure 33-C)

FIGURE 33-A Indication of the leak

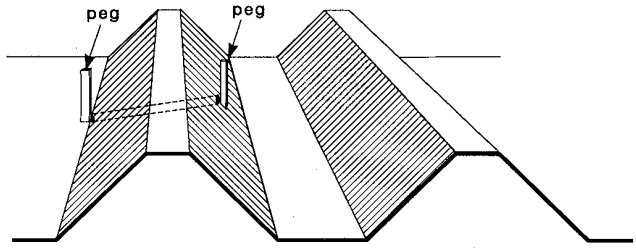


FIGURE 33-B Excavation of the canal bank below and beside the leak

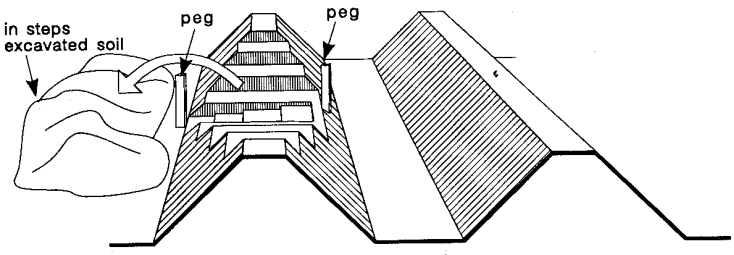
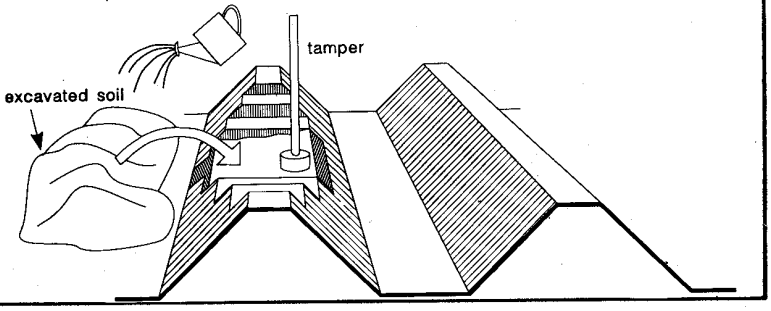


FIGURE 33-C Filling each layer and compacting the moist soil



For lined canals, the same procedure as above can be followed but with one difference: before the bank is excavated, part of the canal lining should be removed. After filling and compacting the earth bank, the lining should be reconstructed.

NOTE 1: Repair of a crack in the canal lining alone will not be sufficient, as the lining could be severely undermined by the leaking water, which will quickly cause a new hole or crack to appear in the lining.

NOTE 2: Joints between lined sections of a canal should be sealed periodically to avoid leakages.

5.5 HOW TO AVOID OVERTOPPING

Overtopping of a canal section is caused by an excessive discharge in that section in relation to the actual canal capacity. Canal banks which are frequently overtopped are very probably eroded and lowered, and thus the actual capacity will be less than the original capacity for which the canal has been designed. Overtopping can be avoided in two ways, either:

- reduce the discharge, or
- increase the canal capacity.

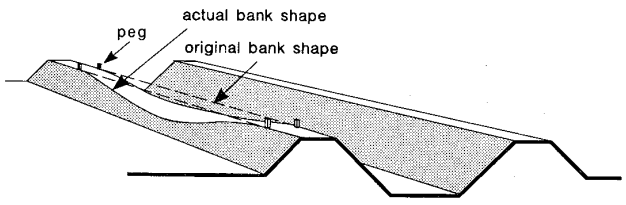
No explanation is necessary for the first solution, and so only the second solution, which re-establishes the canal capacity, is described below.

The procedure to re-establish a canal capacity by rebuilding its banks is:

Step 1 Remove the vegetation, if any.

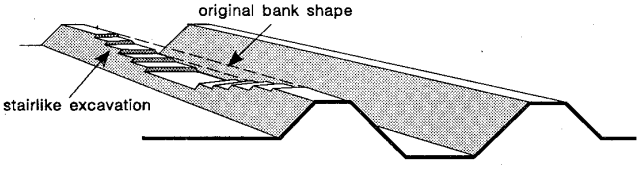
Hammer pegs in the canal bank at both sides of the section concerned. (Figure 34-A) (With these pegs and a rope the level of the section can be checked).

FIGURE 34-A Lowered section of a canal bank



Step 2 Excavate the top and sides of the bank like stairs. (Figure 34-B)

FIGURE 34-B Stair-like excavation of the bank



Step 3 Rebuild the bank by filling the excavated portion with clayey soil. Fill by layers of 5 to 10 cm and compact it in wet condition. (Figure 34-C)

While raising the embankment, check the level regularly.

Step 4 Trim the sides and lay grass sods on the bank when the top is reached. (Figure 34-D).

When it is impossible to avoid high water levels, an emergency outlet, or spillway, can be installed. An emergency outlet consists of a protected lowered section of a canal embankment and a protected outlet to the drainage system. Such a structure will allow water to escape into the drainage system without damaging the canal banks.

The level and the length of the structure should be such that the excess discharge can be safely evacuated and the water level will not rise higher than the highest allowed water level (free board level).

FIGURE 34-C Refilling and compaction of each layer in a wet condition

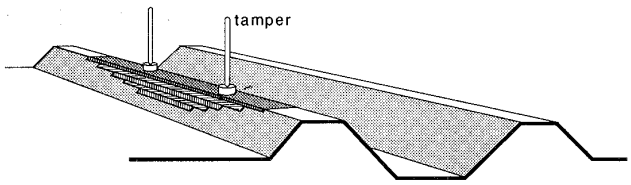


FIGURE 34-D Finishing the bank and laying grass sods once the top is reached

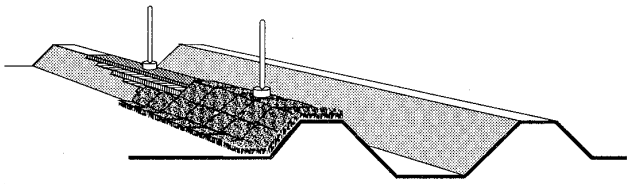


FIGURE 35
Emergency outlet

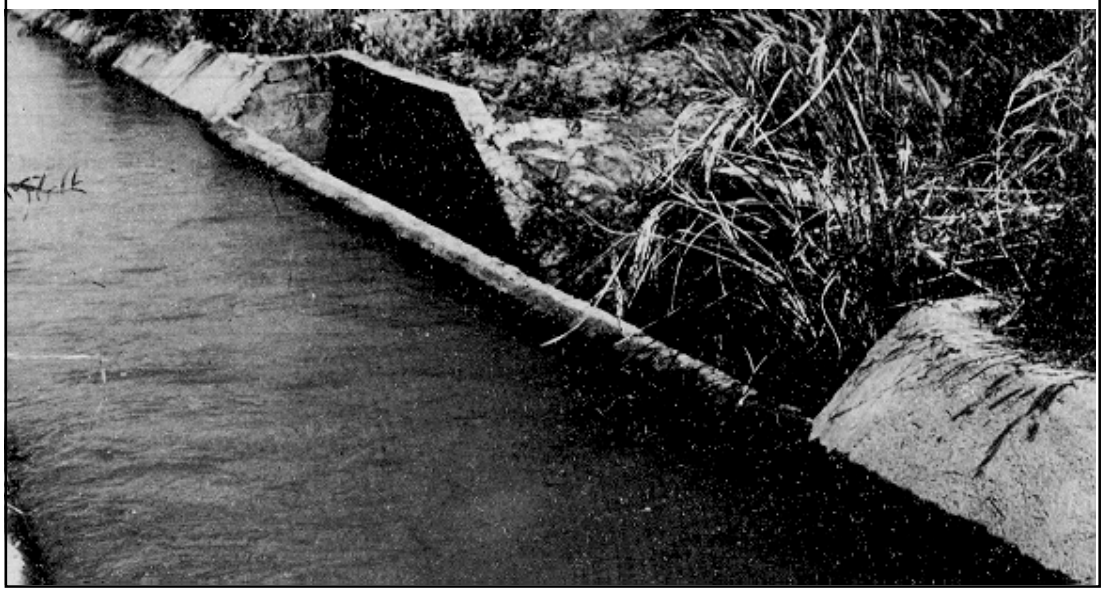


Figure 35 shows an emergency outlet. The water level is lower than the crest of the emergency outlet. An engineer should be consulted for the design and the installation of an emergency outlet.

5.6 CANAL REPAIR AND PREVENTING EROSION

5.6.1 Repair

An eroded canal or canal embankment needs at some time to be reshaped. First the repair of an eroded canal is described, and second the repair of gullies and cracks in an eroded canal embankment.

Reshaping an eroded cross-section

The reshaping and widening of an eroded cross-section involves the following steps:

Step 1 Construct a wooden template.

If the original side slopes had been constructed too steeply and thus were unstable, make the template so that the new side slopes are flatter. The top width of the canal is then larger while the bed width remains the same. Care must be taken to avoid narrowing the original canal bank crest widths. (Figure 36-A)

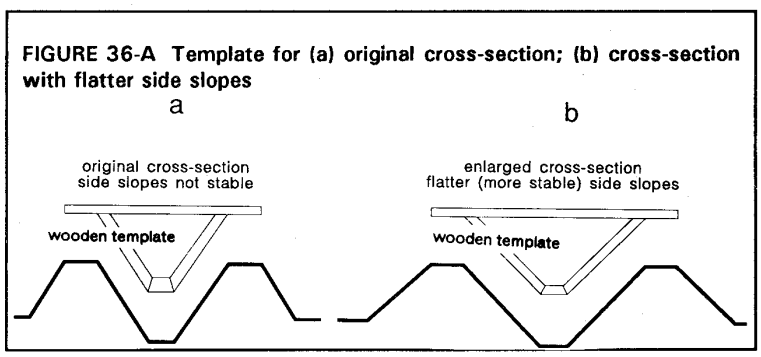


FIGURE 36-A Template for (a) original cross-section; (b) cross-section with flatter side slopes

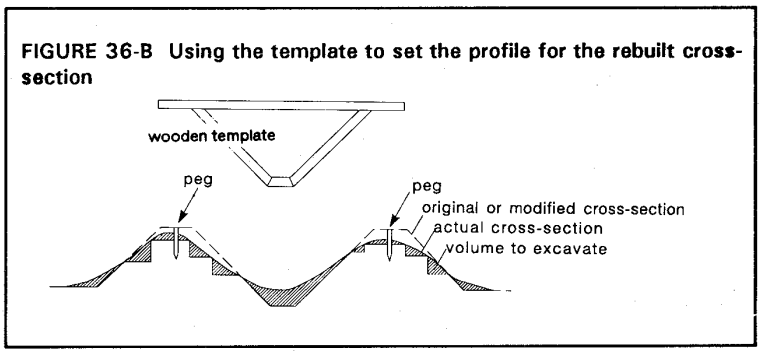


FIGURE 36-B Using the template to set the profile for the rebuilt cross-section

Step 2 Hammer in reference pegs to indicate the original level of the canal banks on each side of the canal. Excavate the bed and sides of the eroded canal section in steps until they reach slightly below the actual bed level so that the new soil to be placed will make better contact with the original ground surface. (Figure 36-B)

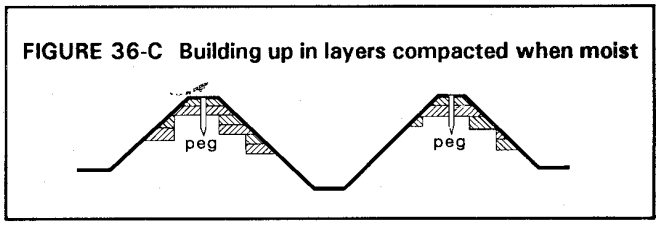


FIGURE 36-C Building up in layers compacted when moist

Step 3 Fill and compact moist soil layer by layer, using the template for final shaping. Each layer to be compacted should not be thicker than 5 to 10 cm. (Figure 36-C)

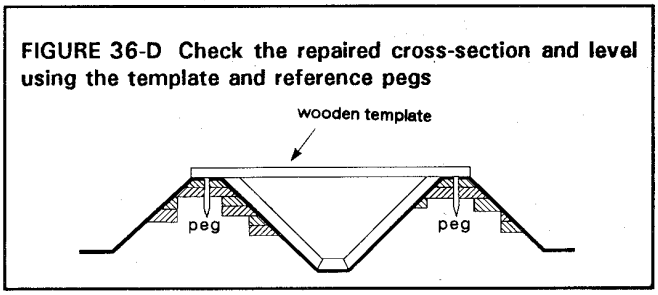


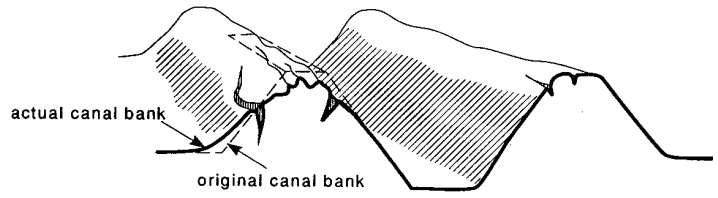
FIGURE 36-D Check the repaired cross-section and level using the template and reference pegs

Step 4 Check the cross-section and bank levels with the template and the reference pegs. (Figure 36-D)

Repair of cracks and gullies in a canal embankment
The repair of cracks and gullies can be executed as follows:

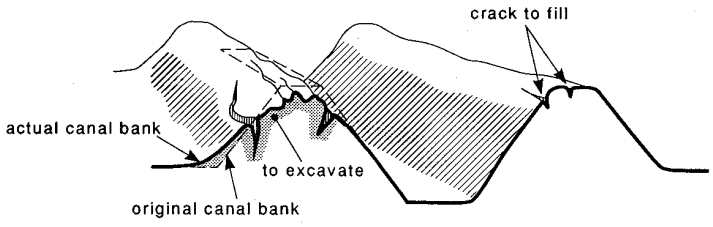
Step 1 Remove any plants from banks which show cracking and in which small gullies have been formed by overtopping water or by heavy rainfall. (Figure 37-A)

FIGURE 37-A Identification of cracks and gullies to be repaired



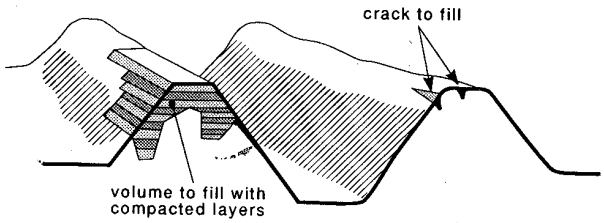
Step 2 In the case of deep cracks and gullies, excavate the bank partly. Small cracks are to be filled with fine-textured soil, moistened and compacted. (Figure 37-B)

FIGURE 37-B Excavating the weakened areas



Step 3 Rebuild the bank by filling in layers and compacting the moist soil. (Figure 37-C)

FIGURE 37-C Repairing with compacted layers of moist soil



5.6.2 Preventing erosion

Erosion of an irrigation canal may be prevented by either:

- reducing the flow velocity, or
- lining the canal.

Reducing the flow velocity

The flow velocity in a canal can be reduced by reducing the canal bed slope. Usually the canal bed follows the slope of the terrain, which may have a slope which is too steep for a canal. To avoid such an excessive canal bed slope in the steep area, the slope of the canal can be modified by constructing part of the canal in cut and part in fill, which however involves moving large volumes of earth. The volume of earth movement in cut and fill can be reduced by installing drop structures, which connect two sections of a canal with different elevations. See Figures 38-A to C.

FIGURE 38-A
Steep canal to be modified

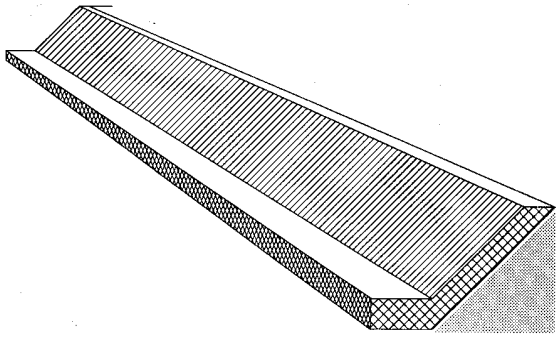


FIGURE 38-B
Reducing canal slope by fill

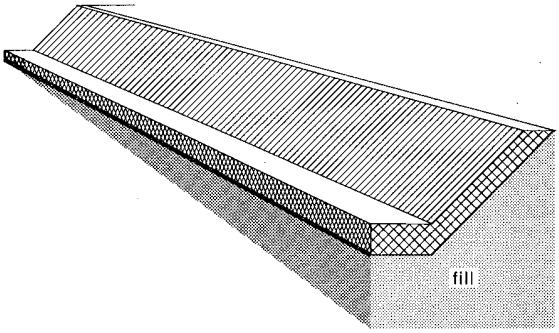
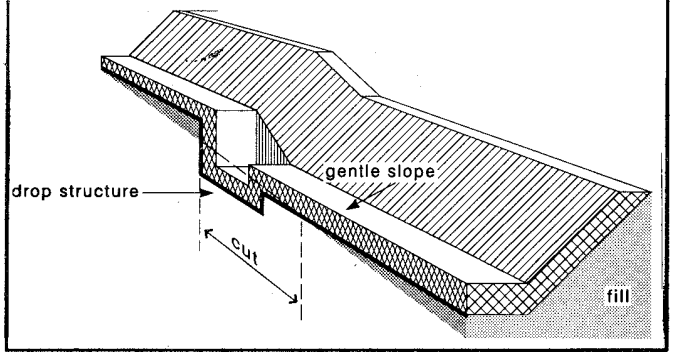


FIGURE 38-C
Reducing slope in a canal by use of a drop structure



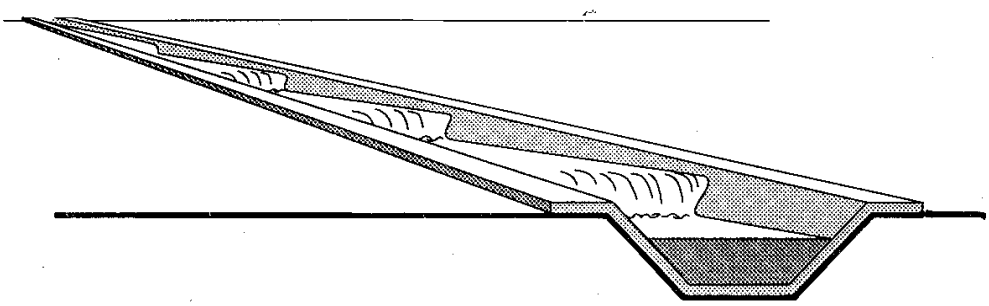
When the slope of a canal is reduced with the installation of drop structures, the flow velocity will be less than before. In order to have the same canal capacity, the canal cross-section has to be made bigger.

Figure 38-A shows a canal section which has the same slope as the field. The field slope is steep and the flow velocity in the canal exceeds its limiting value, causing erosion of the canal. Figure 38-B shows a canal section where a flatter slope is obtained by modifying the existing field slope by cut and fill, but a large volume of earth has to be moved in this case to achieve a canal bed slope which does not cause erosion. The volume of earth to be moved increases as the differ-ence between the natural field slope and the canal slope is made larger. Figure 38-C shows a canal section with the same overall canal slope of the section in Figure 38-B, but the volume of earth to be moved in this case is much less than in Figure 38-B, but at the cost of including a drop structure, which has to be constructed.

Of course, it is not easy to rebuild an existing canal in order to modify its bed slope. In such a case it is possible to install series of check structures in the canal to reduce the flow velocity, as in Figure 39. See also Training Manual 8, *Structures*, in this series.

Consult an engineer for installing drop or check structures.

FIGURE 39
Series of checks in a steeply sloping canal



Lining the canal

Canal sections which are eroded by fast flowing water can be lined.

- The limiting flow velocity of a lined canal is higher than that of an equivalent unlined canal. Thus the canal slope can be steeper.
- Because the flow velocity in a lined canal can be higher than that in an unlined canal, the cross-section of a lined canal can be smaller than that of an unlined canal carrying a similar discharge.

Lining of canal sections is described in the next chapter.