1. Cross-section of an irrigation canal

1.1 Components of cross-section:

1) Side slopes
2) Berms
3) Freeboard
4) Banks
5) Service roads
6) Back Berm or Counter Berms
7) Spoil Banks
8) Borrow Pits

Figure 1 demonstrated all components of irrigation canal cross section.

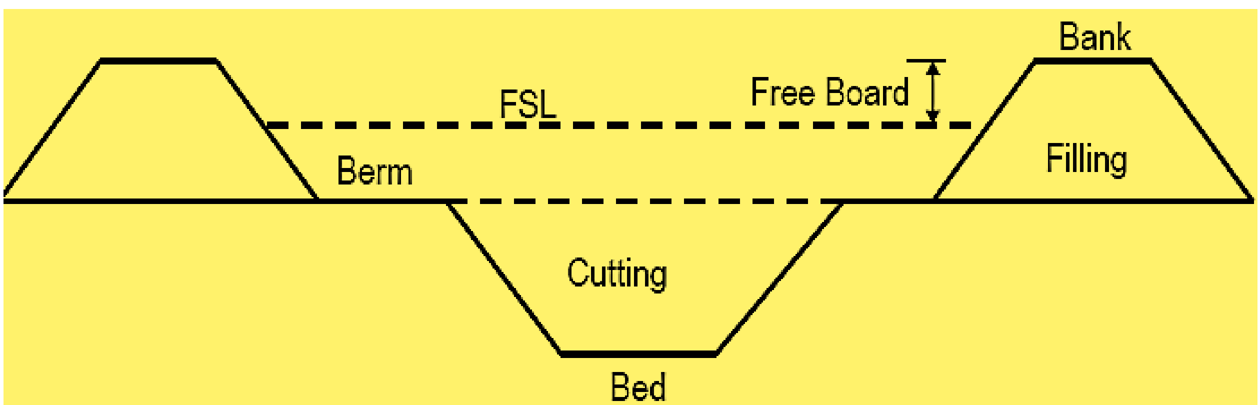
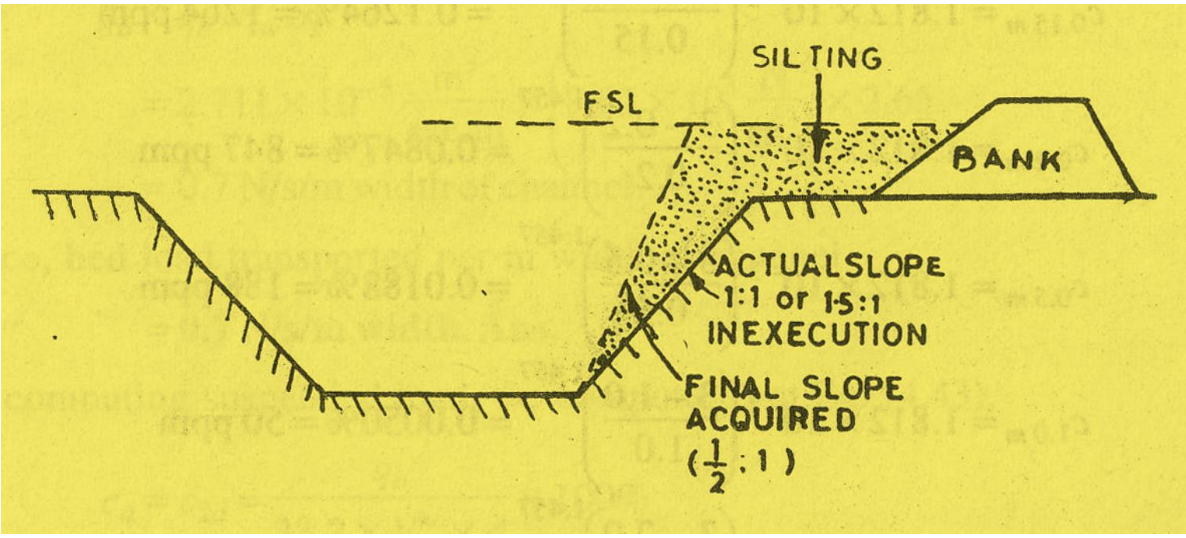


Figure 1

1) Side Slopes: The side slopes should be such that they are stable, depending upon the type of the soil. A comparatively steeper slope can be provided in cutting rather than in filling, as the soil in the former case shall be more stable.

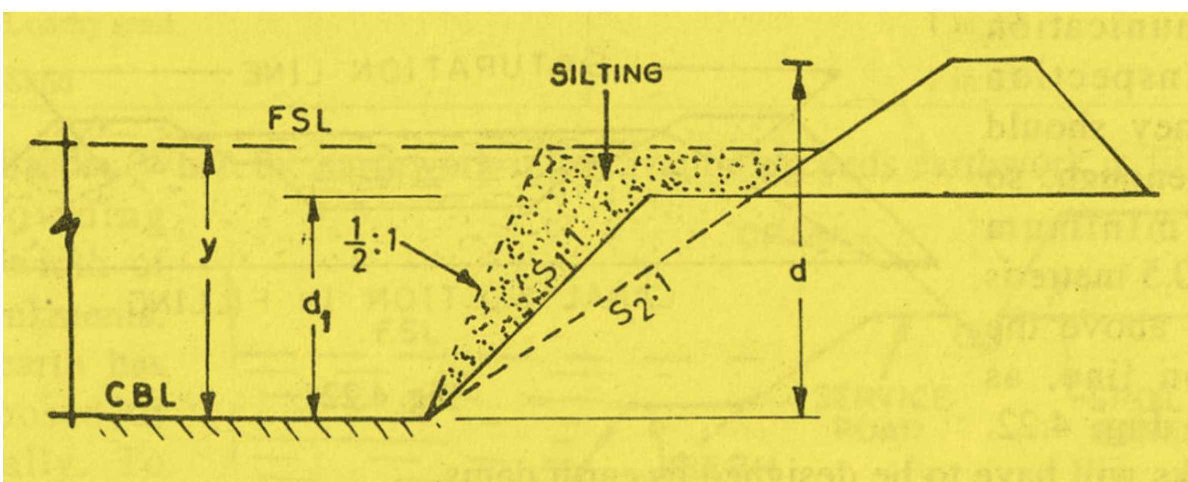


For cutting canals, the side slope is (1H: 1V to 1.5 H: 1V)

For filling canals, the side slope is (1.5 H: 1V to 2H: 1V)

2) Berms: Berm is the horizontal distance left at ground level between the toe of the bank and the top edge of cutting.

The berm is provided in such a way that the bed line and the bank line remain parallel. If s1: 1 is the slope in cutting and s2:1 in filling, then the initial berm width = $(s_2 - s_1) \times d_1$



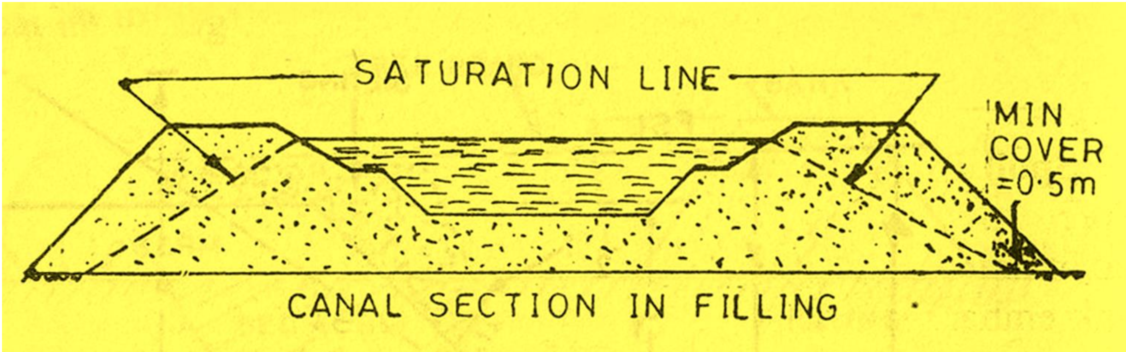
Advantage of Berms:

a) Help the channel to attain regime conditions.
b) Give additional strength to the banks and provide protection against erosion and breaches.
c) Protect the banks from erosion due to wave action.
d) Provide a scope for future expansions of the canal.

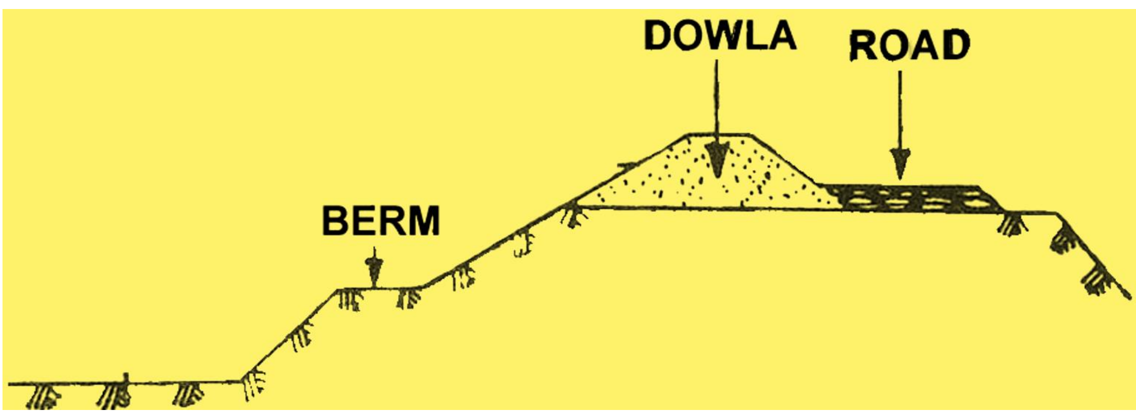
3) Freeboard: The margin between FSL (full supply level) and bank level is known as freeboard. The amount of freeboard depends upon the size of the channel. The generally provided values of freeboard are given in the table below:

Discharge (m^3/s)	Extent of freeboard (m)
1 to 5	0.50
5 to 10	0.60
10 to 30	0.75
30 to 150	0.90

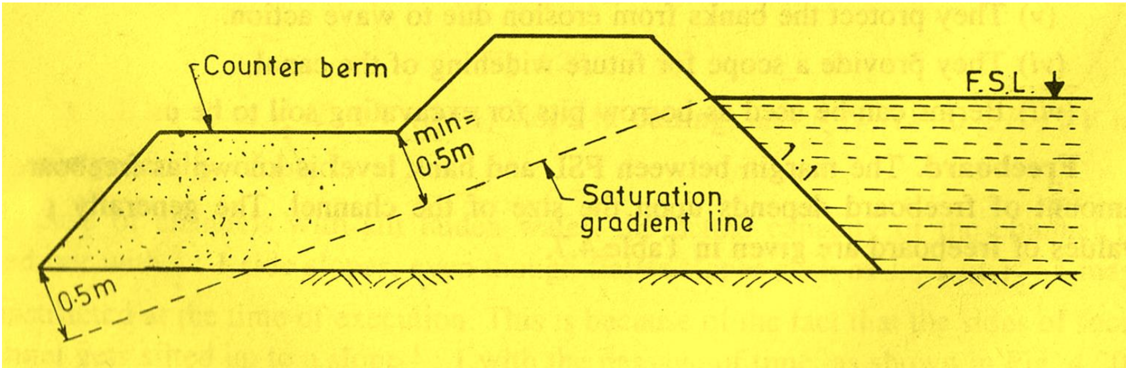
4) Banks: The primary purpose of banks in to remain water. This can be used as means of communication and as inspection paths. They should be wide enough, so that a minimum cover of 0.50 m is available above the saturation line.



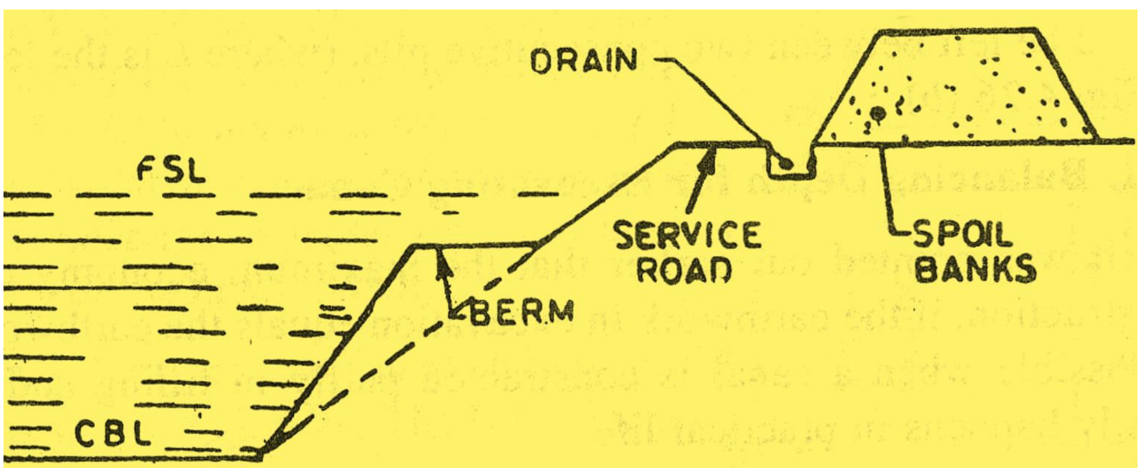
5) Service Roads: Service roads are provided on canals for inspection purposes, and may simultaneously serve as the means of communication in remote areas. They are provided 0.4 m to 1.0 m above FSL, depending upon the size of the channel.



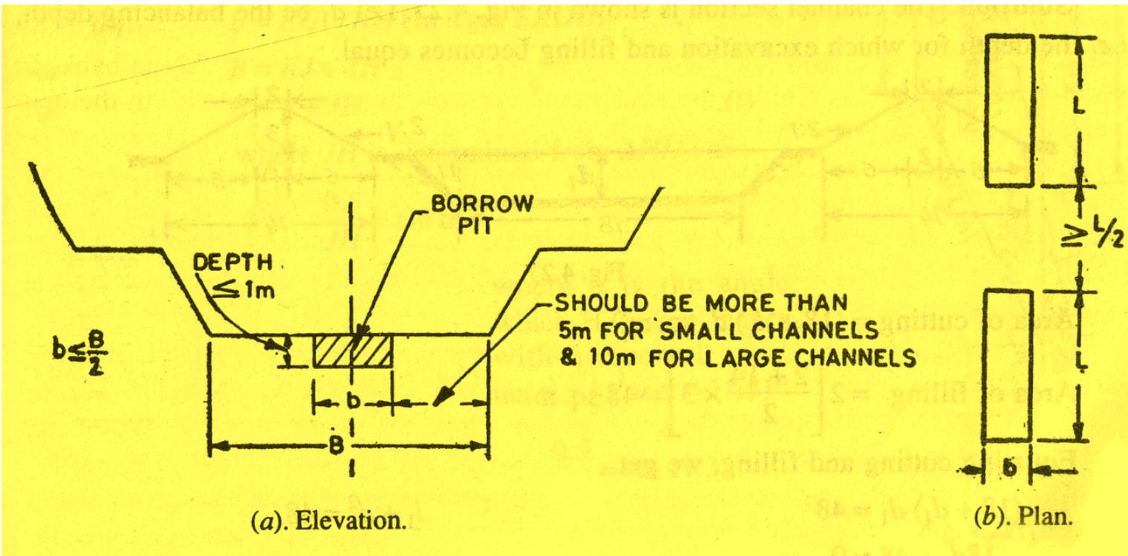
6) Back Berms or Counter Berms: Even after providing sufficient section for bank embankment, the saturation gradient line may cut the downstream end of the bank. In such a case, the saturation line can be kept covered at least by 0.5 m with the help of counter berms as shown in figure below.



7) Spoil Banks: When the earthwork in excavation exceeds earthworks in filling, even after providing maximum width of bank embankments, the extra earth has to be disposed of economically. To arrange of this earth by mechanical transport, etc. may become very costly, and an economical mode of its disposal may be found in the form of collecting this soil on the edge of the bank embankment itself.



8) Borrow Pits: When earthwork in filling exceeds the earthwork in excavation, the earth has to be brought from somewhere. The pits, which are excavated for bringing earth, are known as **Borrow Pits**.



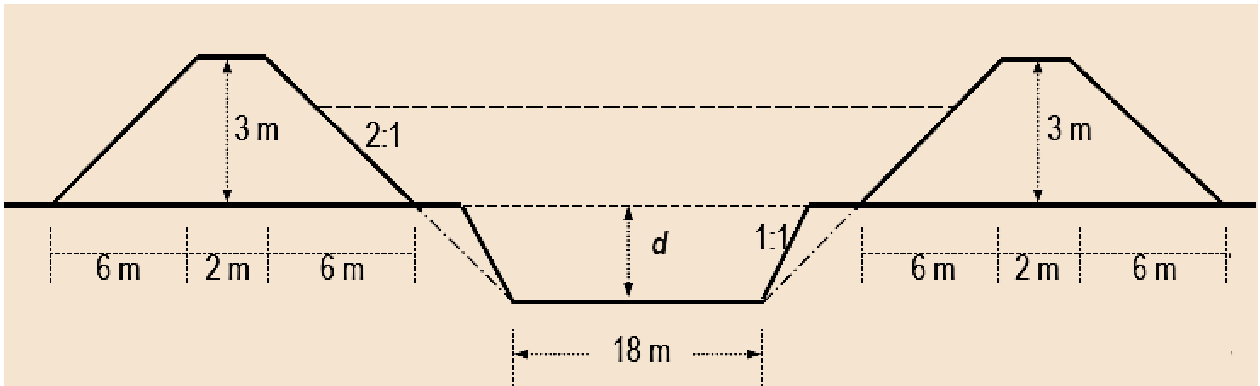
(*a*). Elevation. (*b*). Plan.

2. Design Steps and Limitations of Borrow Pits:

1) The borrow pits should start from a point at a distance more than 5 m from the toe for small channels, and 10 m for large channels.
2) The width of these pits ***b***, should be less than half the width of the canal ***B***, and should be excavated in the entire.
3) The depth of these pits should be equal to or less than 1 m.
4) Longitudinally, these pits should not run continuous, but a minimum space of (***L*/2**) should be left between two consecutive pits, (where ***L*** is the length of one pits).

Example [1]:

Calculate the ***balancing depth*** for a channel section having a bed width equal to 18 m and side slopes of 1:1 in cutting and 2:1 in filling. The bank embankments are kept 3.0 m higher than the ground level (berm level) and crest width of banks is kept as 2.0 m.



Solution:

For the channel, section is shown above.

Let ***d*** be the balancing depth, i.e. the depth for which excavation and filling becomes equal.

Area of cutting = $(18 + d)\times d$ m^2

Area of filling = $2(2+14)/2\times 3 = 48$ m^2

Area of cutting = Area of filling = = > yields;

$(18 + d)\times d = 48$

$\therefore\ d^2 + 18d - 48 = 0$

$\therefore\ d = -2.35$ m (neglected),

Thus, balancing depth (d) = 2.35 m.