Canal Irrigation

Introduction

A canal is defined as an artificial channel constructed on the ground to carry water from a river or another canal or a reservoir to the fields.

Types of Canals

Pranamesh Chakraborty

Types of Canals

(BASED ON SOURCE OF SUPPLY)

Permanent Canal

- Continuous source of water supply.
- Also called perennial canals

Inundation Canal

- Draws its supplies from a river only during the high stages of the river.

Types of Canals

(BASED ON FUNCTION)

Irrigation Canal	• Carries water from its source to agricultural fields.
Navigation Canal	• Used for transport of goods.
Power Canal	• Used to carry water for generation of hydroelectricity.
Feeder Canal	• Feeds two or more canals.

Note, a canal can serve more than one purpose.

Pranamesh Chakraborty

Types of Canals

(BASED ON ALIGNMENT)

- Watershed Canal or Ridge Canal
- Contour Canal
- Side Slope Canal

Watershed canal or Ridge canal

Watershed canal or Ridge canal (Contd.)

- The dividing ridge line between the catchment areas of two streams (drains) is called the **watershed or ridge canal.**

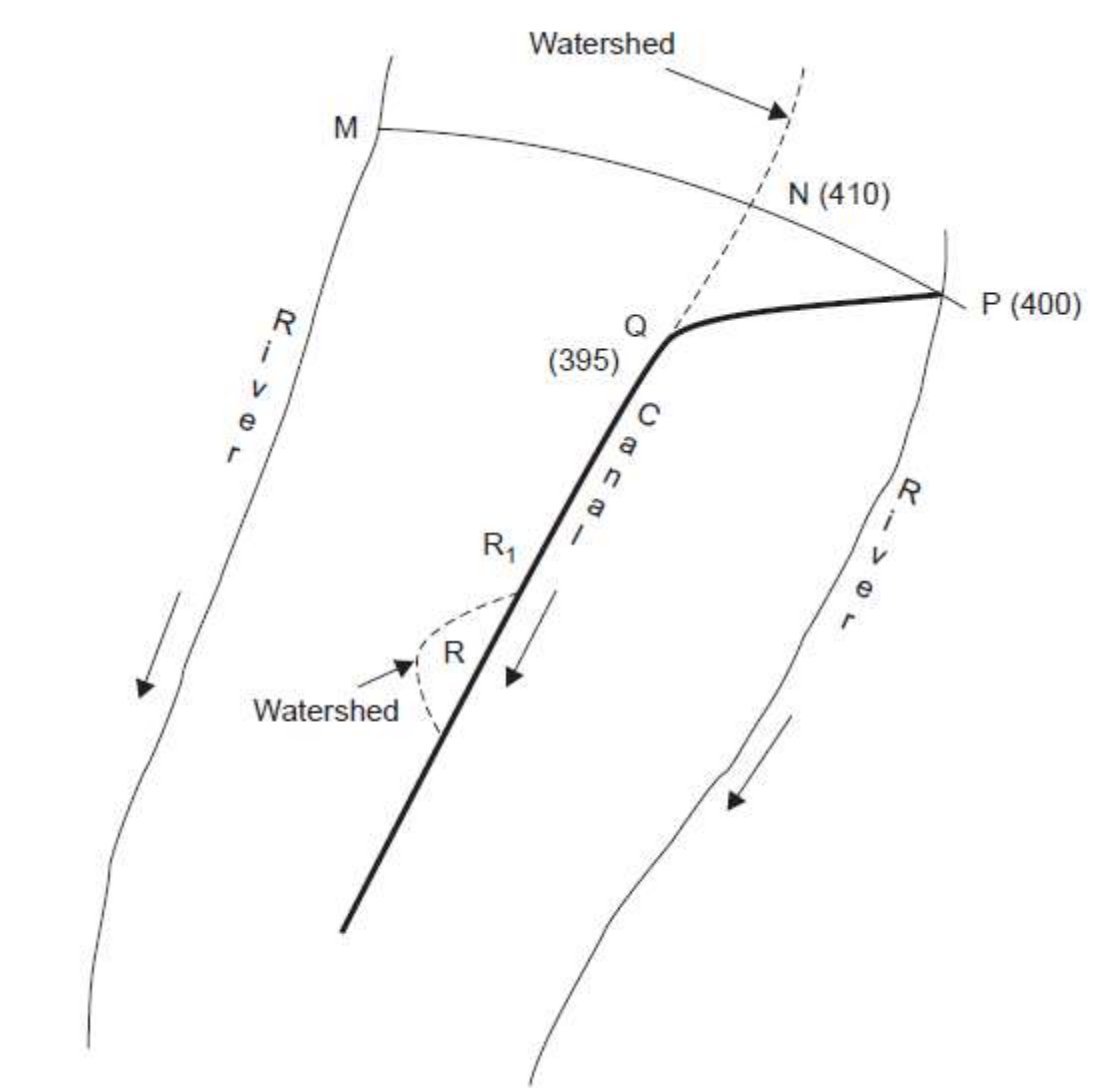
- Thus between two major streams, there is the main watershed (ridge line), which divides the drainage area of the two streams.

Watershed canal or Ridge canal (Contd.)

- *The canal which is aligned along any natural watershed (ridge line) is called a watershed canal, or a ridge canal.* Aligning a canal (main canal or branch canal or distributary) on the ridge ensures gravity irrigation on both sides of the canal.

- Since the drainage flows away from the ridge, no drainage can cross a canal aligned on the ridge. *Thus, a canal aligned on the watershed saves the cost of construction of cross-drainage works.*

Watershed canal or Ridge canal (Contd.)

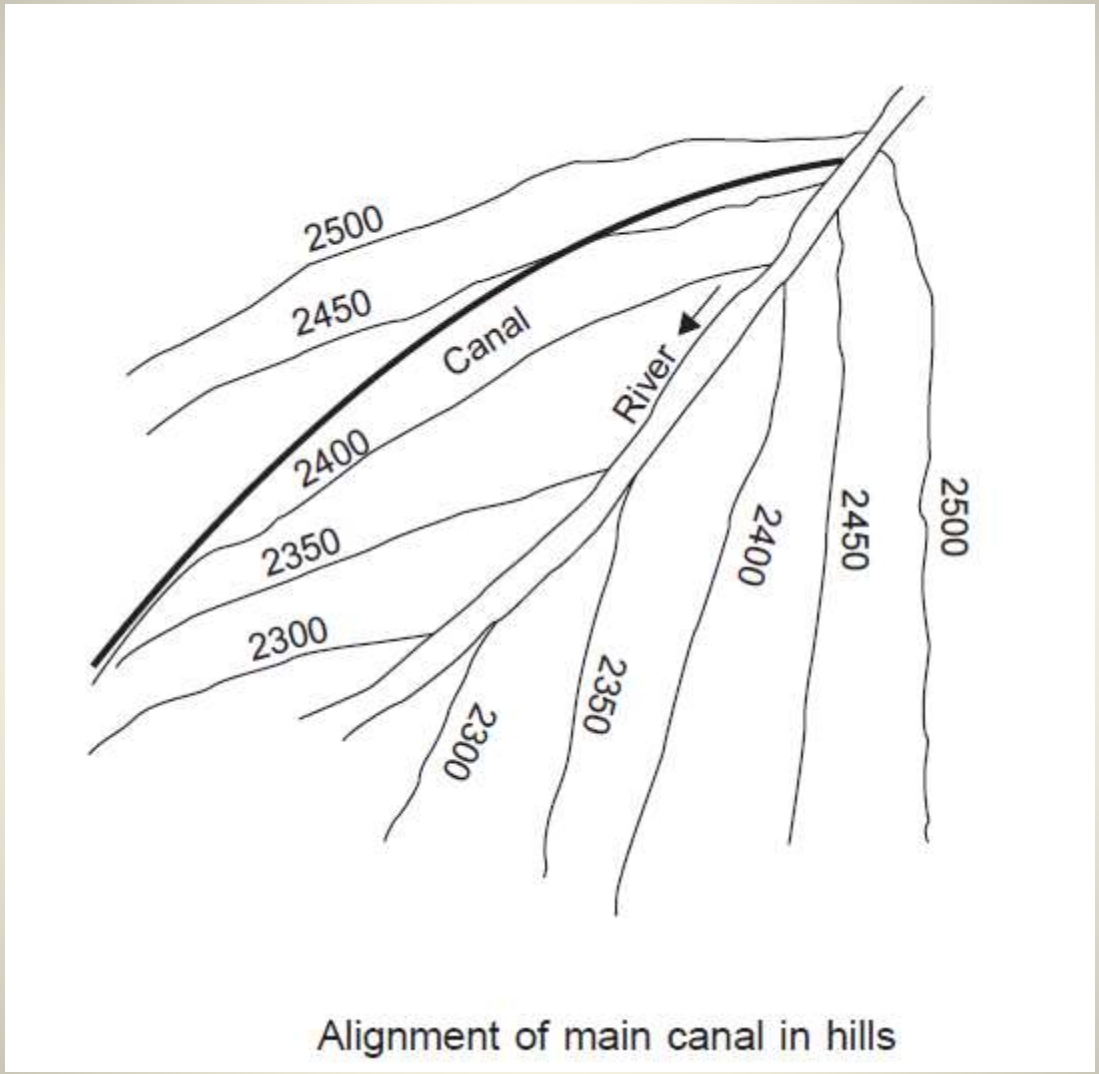


Head reach of a main canal in plains

Contour Canal

- Watershed canal along the ridge line are not found economical in hill areas. In hills, the river flows in the valley well below the watershed.
- In fact, the ridge line (watershed) may be hundred of meters above the river. It therefore becomes virtually impossible to take the canal on top of such a higher ridge line. In such conditions, contour canals are usually constructed.
- *A contour canal irrigates only on one side because the area on the other side is higher.*

Contour Canal (Contd.)



Alignment of main canal in hills

Side Slope Canal

- A side slope canal is that which is aligned at right angles to the contours; i.e. along the side slopes.
- Since such a canal runs parallel to the natural drainage flow, it usually does not intercept drainage channels, thus avoiding the construction of cross-drainage structures.
- It is a canal which is aligned roughly at right angle to contours of the country but not on watershed or valley.

Side Slope Canal (Contd.)

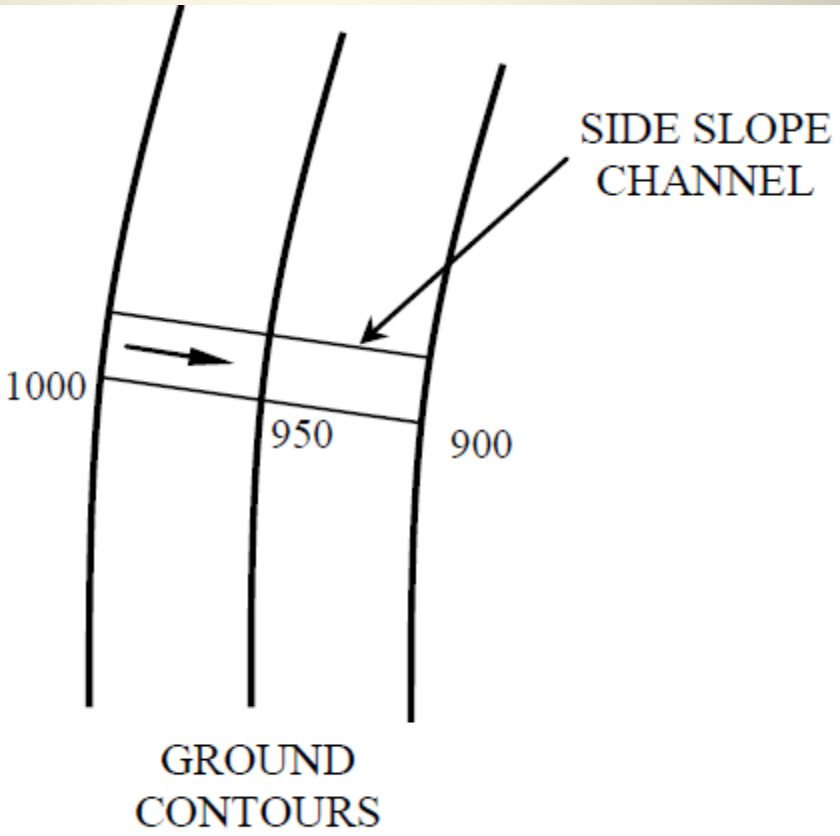


Fig: Alignment of a side slope canal

Types of Canals

(BASED ON DISCHARGE)

- Main Canal
- Branch Canal
- Major Distributary
- Minor Distributary
- Water Course

Pranamesh Chakraborty

MAIN CANAL

- Main Canal takes off directly from the upstream side of weir head works or dam.

- Usually no direct cultivation is proposed

The Danube-Black Sea Canal in Romania

BRANCH CANAL

- All offtakes from main canal with head discharge of 14-15 cumecs and above are termed as branch canals.

- Acts as feeder channel for major distributaries

A BRANCH CANAL IN MADRAS

MAJOR DISTRIBUTARY

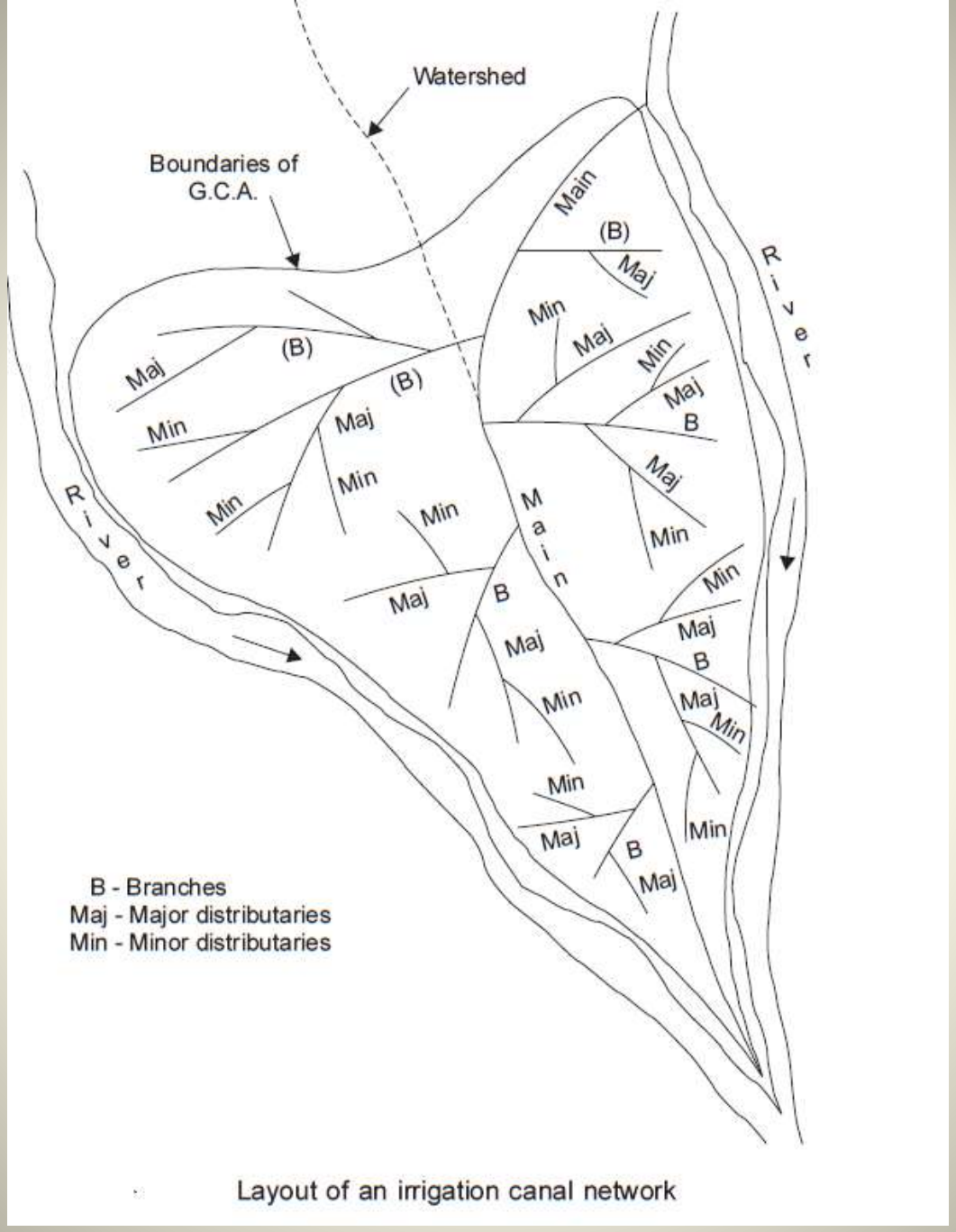
❖ All offtakes from main canal or branch canal with head discharge from 0.25 to 15 cumecs are termed as major distributaries.

MINOR DISTRIBUTARY

❖ All offtakes taking off from a major distributary carrying discharge less than 0.25 cumec are termed as minor distributaries

WATER COURSE

❖ Small channels which carry water from the outlets of a major or minor distributary or a branch canal to the fields to be irrigated.



Layout of an irrigation canal network

Types of Canals

(Based on lining provided or not)

Unlined Canal

- Bed and banks made up of natural soil.
- Water velocities higher than 0.7 m/s are not tolerable.
- High seepage and conveyance water losses.
- Profuse growth of aquatic weeds retards the flow .

Lined Canal

- Lining of impervious material on its bed and banks to prevent the seepage of water.
- Different types of lining used e.g. concrete, brick or burnt clay tile, boulder, etc.

A PICTURE OF A UNLINED CANAL

A PICTURE OF A LINED CANAL

Cross-Section of Irrigation Canal

Pranamesh Chakraborty

Introduction

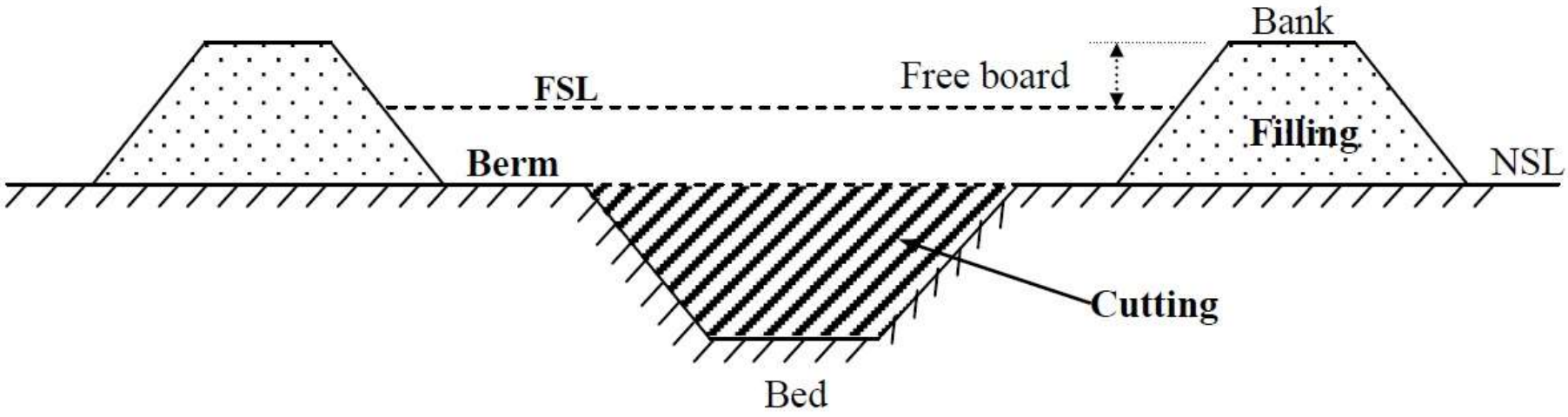


Fig: Typical cross-section of an irrigation canal

FSL= Full Supply Level. NSL=Natural Surface Level

This section is partly in cutting and partly in filling and aims in balancing the quantity of earth work in excavation with that in filling.

Introduction

- When the NSL is above the top of the bank, the entire canal section will have to be in cutting, and it shall be called ‘canal in cutting’.
- Similarly, when the NSL is lower than the bed level of the canal, the entire canal section will have to be built in filling, and it is called ‘canal in filling’.

Components of Cross- Section

- Side slope
- Berm
- Freeboard
- Bank
- Service road
- Back Berm or Counter Berm
- Spoil Bank
- Borrow Pit

Side Slope

- 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.

Berm

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

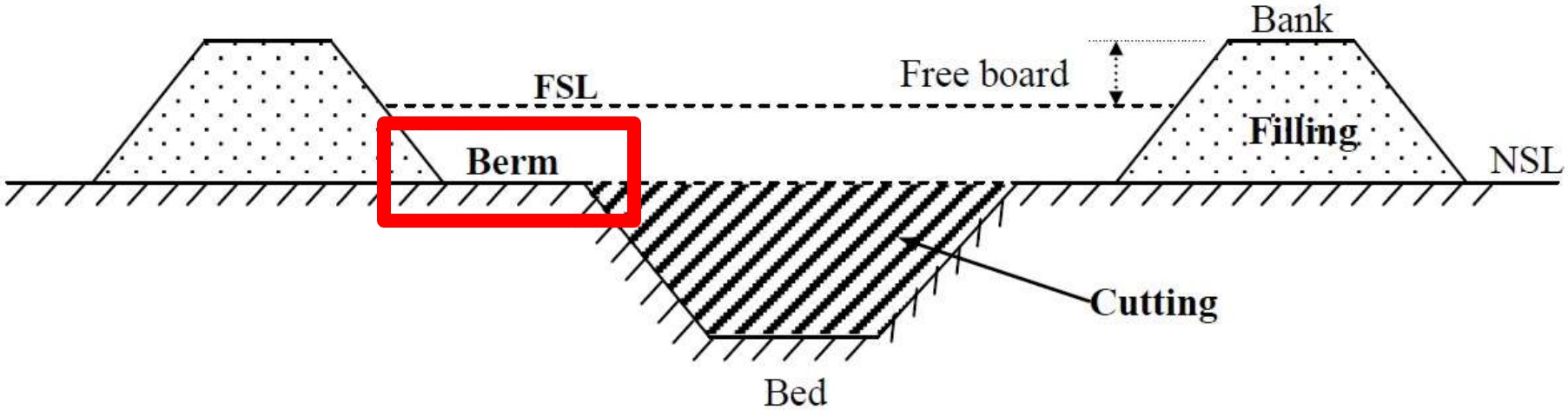


Fig: Typical cross-section of an irrigation canal

Berm (contd.)

Purposes of Berms:

- They give additional strength to the banks and provide protection against erosion and breaches.
- They protect the banks from erosion due to wave action.
- They provide a scope for future widening of the canal.

Freeboard

The margin between FSL and bank level is known as freeboard. The amount of freeboard depends upon the discharge of the channel.

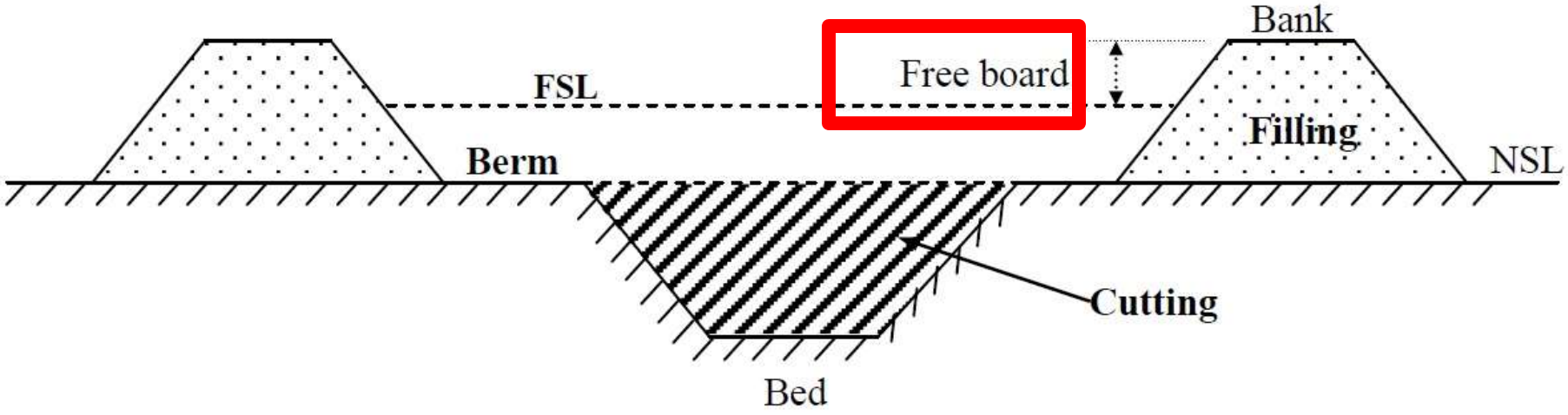


Fig: Typical cross-section of an irrigation canal

Bank

The primary purpose of banks in to retain water. This can be used as means of communication and as inspection paths.

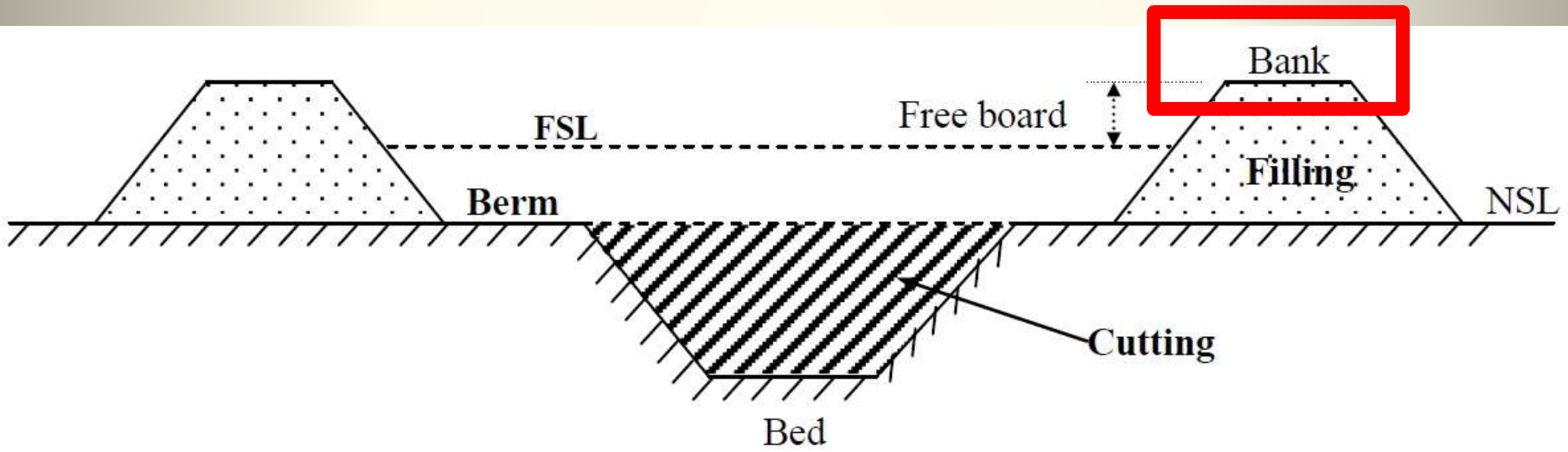
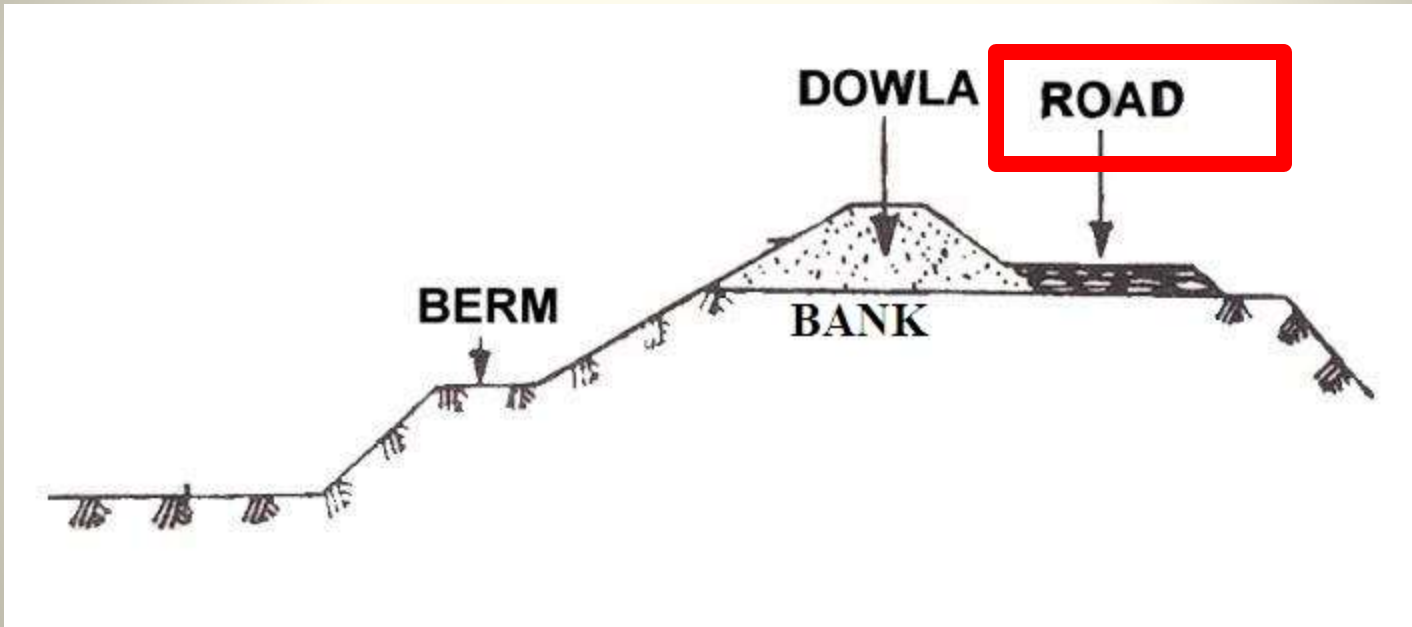


Fig: Typical cross-section of an irrigation canal

Service Road

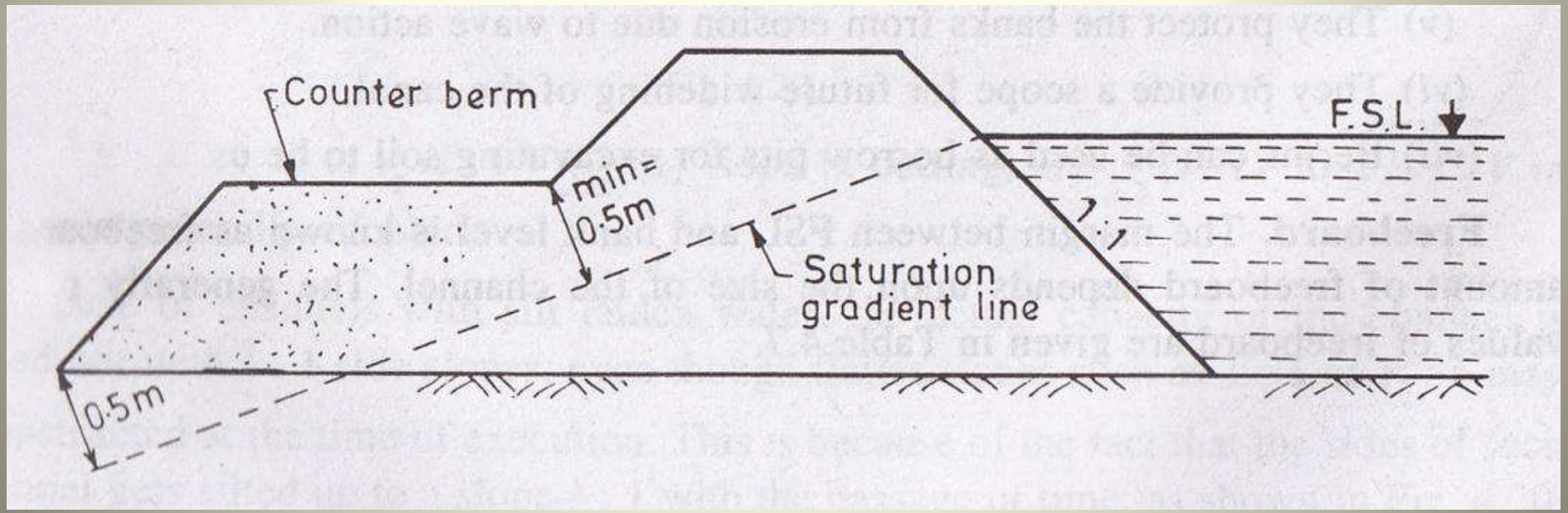
Service roads are provided on canals for inspection purposes, and may simultaneously serve as the means of communication in remote areas.



Dowla: As a measure of safety in driving, dowlas with side slopes of 1.5: 1 to 2:1, are provided along the banks.

Back Berm or Counter Berm

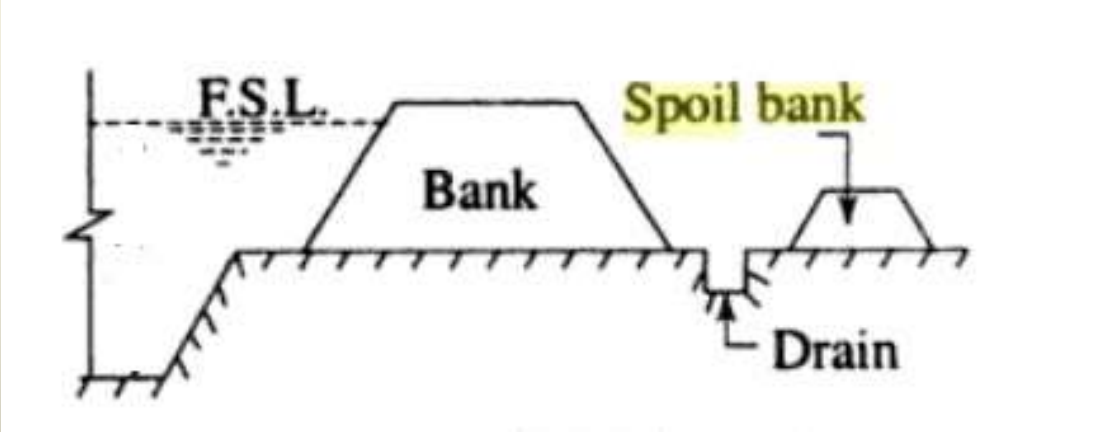
Even after providing sufficient section for bank embankment, the saturation gradient line may cut the downstream end of the bank. In such a case, the saturation line can be kept covered at least by 0.5 m with the help of counter berms as shown in figure below.



Spoil Bank

When the earthwork in excavation exceeds earthworks in filling, the extra earth has to be disposed of economically.

Economical mode of its disposal may be collecting this soil on the edge of the bank embankment itself.

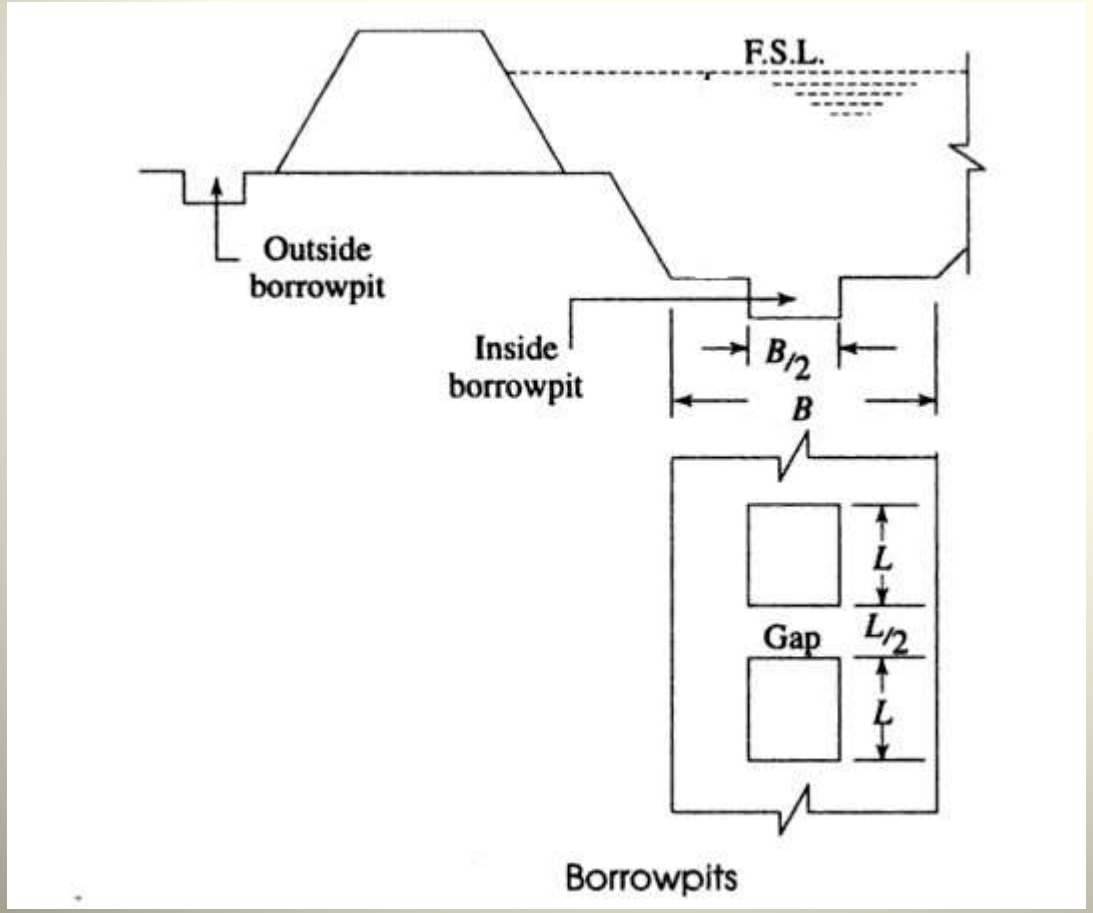


Borrow Pit

- When earthwork in filling exceeds the earthwork in excavation, the earth has to be brought from somewhere.
- The pits, which are dug for bringing earth, are known as borrow pits.
- If such pits are excavated outside the channel, they are known as external borrow pits, and if they are excavated somewhere within the channel, they are known as internal borrow pits.
- Internal borrow pits are more preferred than external one.

Borrow Pit (Contd.)

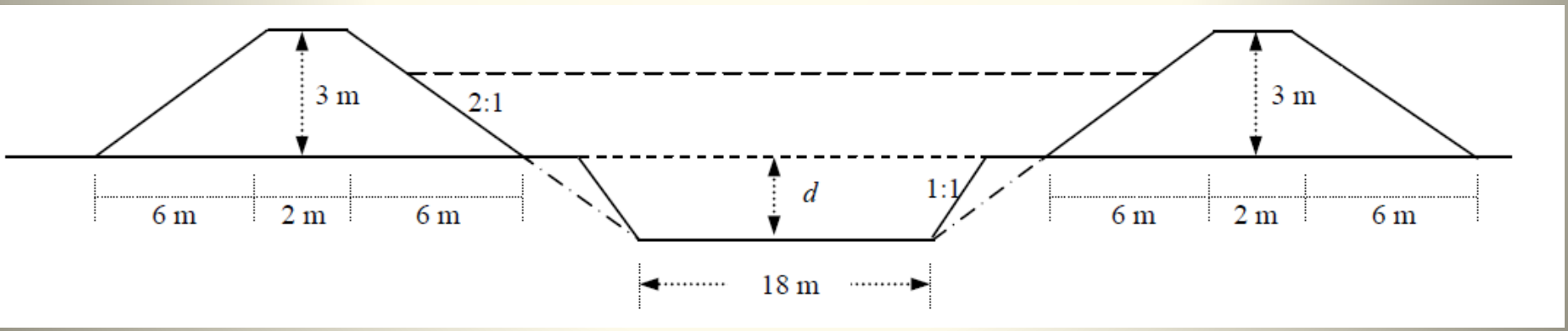
The inside borrow pit may be located at the centre of canal. The idea behind this is that the borrow pits will act as water pockets where the silt will be deposited and ultimately the canal bed will get levelled up.



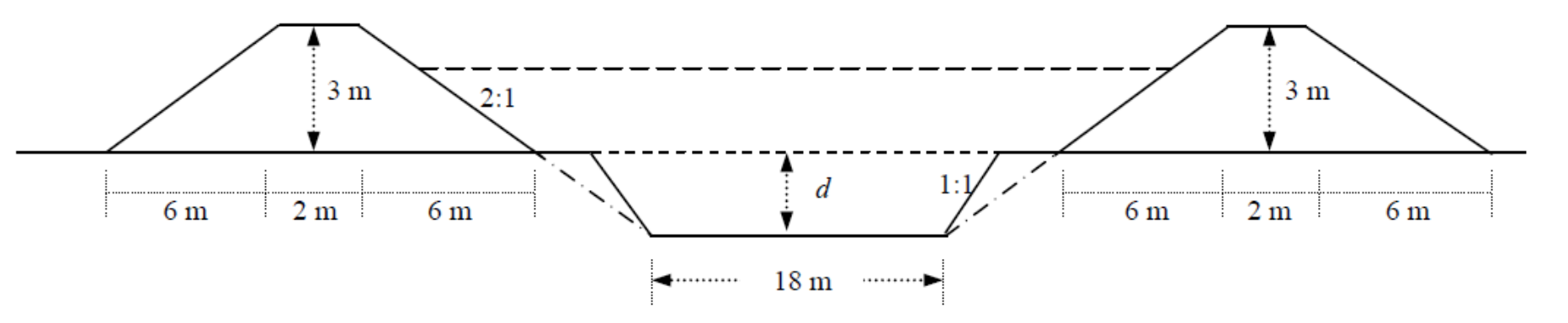
Example

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



Example (Contd.)



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

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

Equating cutting and filling, we get

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

or, $d^2 + 18d - 48 = 0$

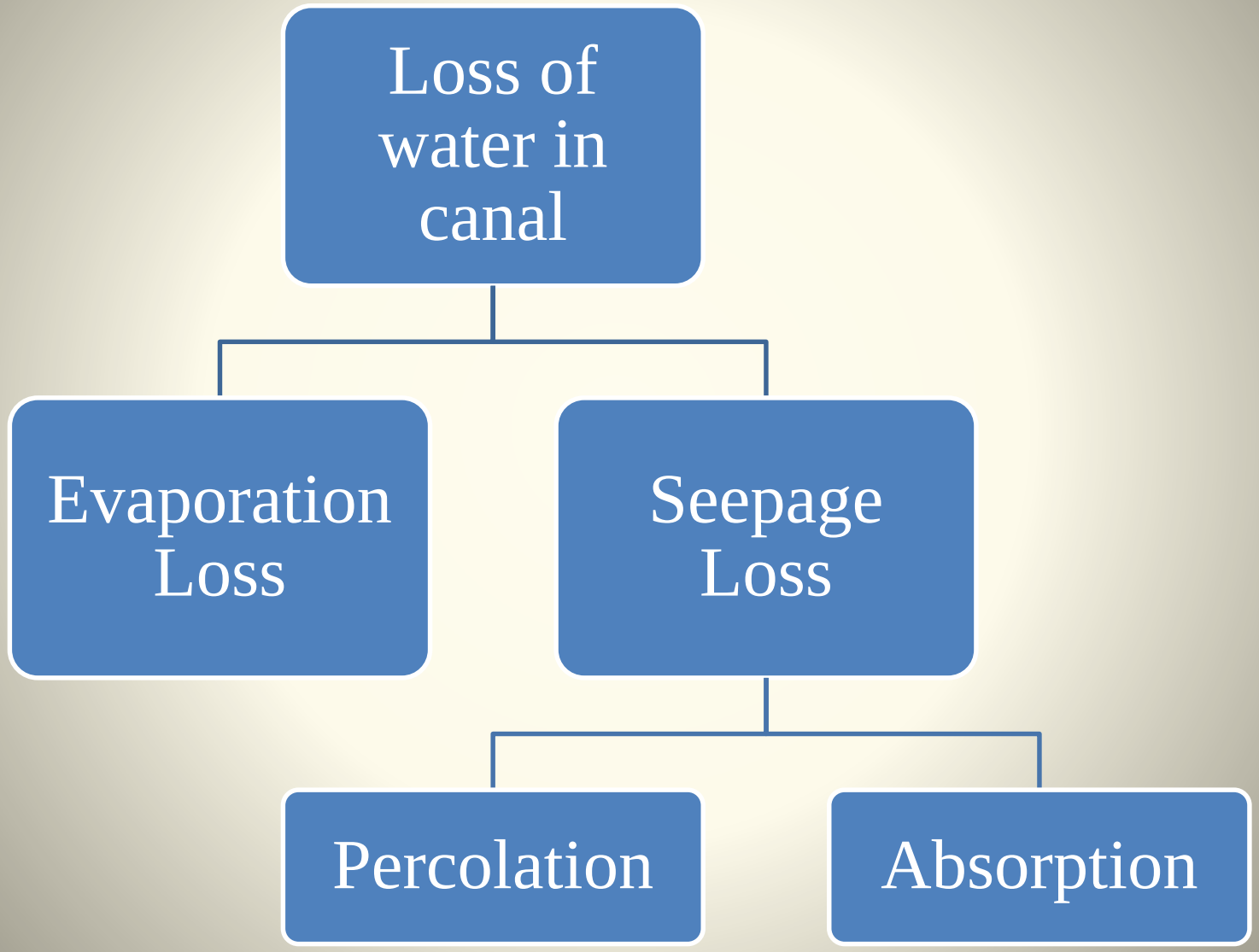
or, $d = 2.35$ m (neglecting –ve sign)

Balancing depth = 2.35 m

Losses of water in canal

Pranamesh Chakraborty

Types of losses of water in canals



Pranamesh Chakraborty

Evaporation Loss

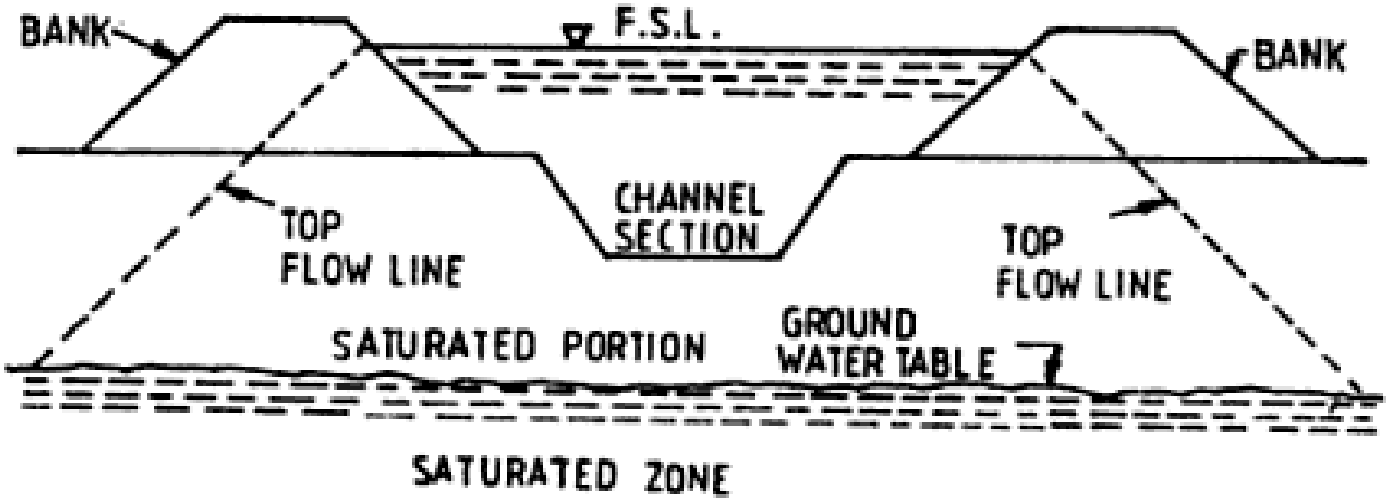
- The water lost by evaporation is generally very small, as compared to seepage loss.

- Evaporation Loss are generally 2-3% of total loss (max. 7% in summer)

Seepage Loss

Percolation:

- In percolation, there exist a zone of continuous saturation from canal to water table and direct flow is established.

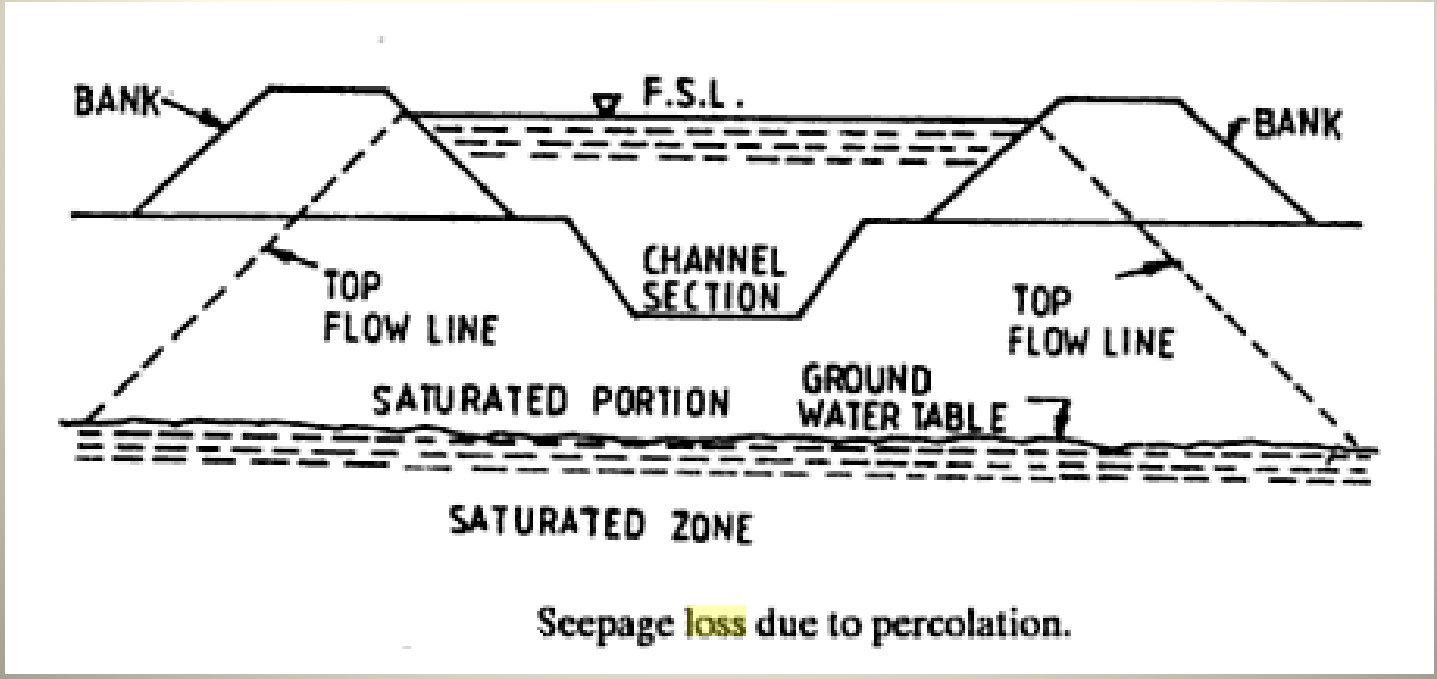


Seepage loss due to percolation.

Seepage Loss

Percolation:

- Almost all water lost from canal reaches ground water reservoir.
- Loss of water depends on the difference of the top water surface level of channel and level of water-table.

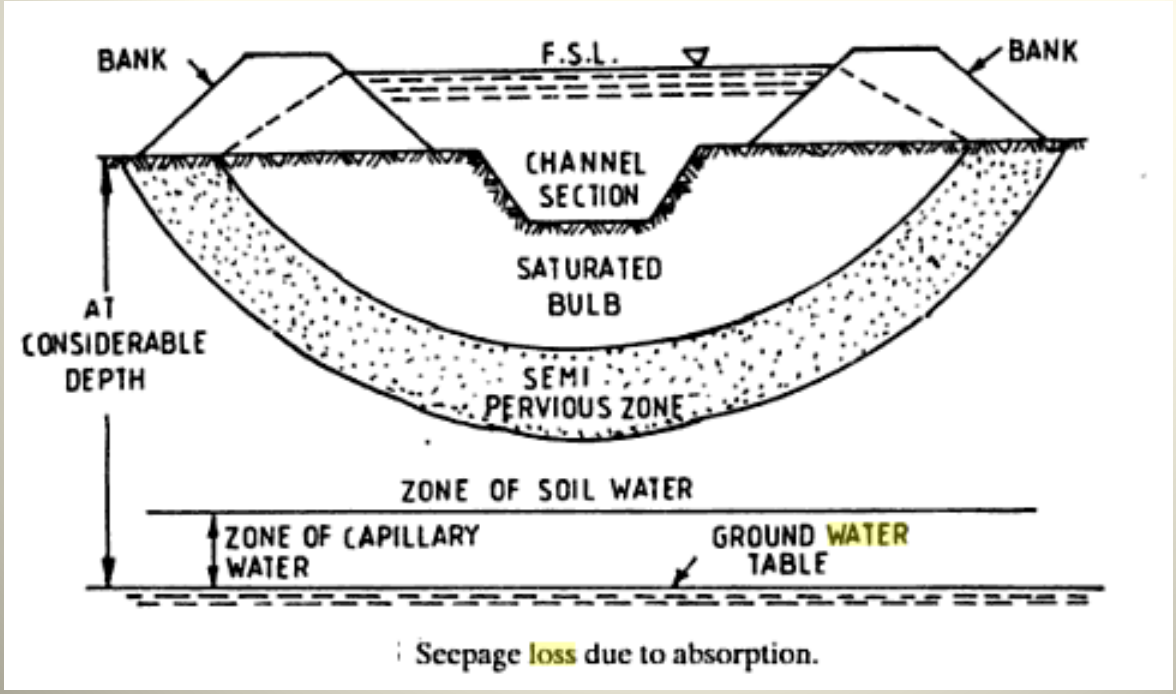


Seepage loss due to percolation.

Seepage Loss

Absorption:

- In absorption, a small saturated zone exist round the canal section and is surrounded by zone of decreasing saturation.
- A certain zone just above water table is saturated by capillarity.

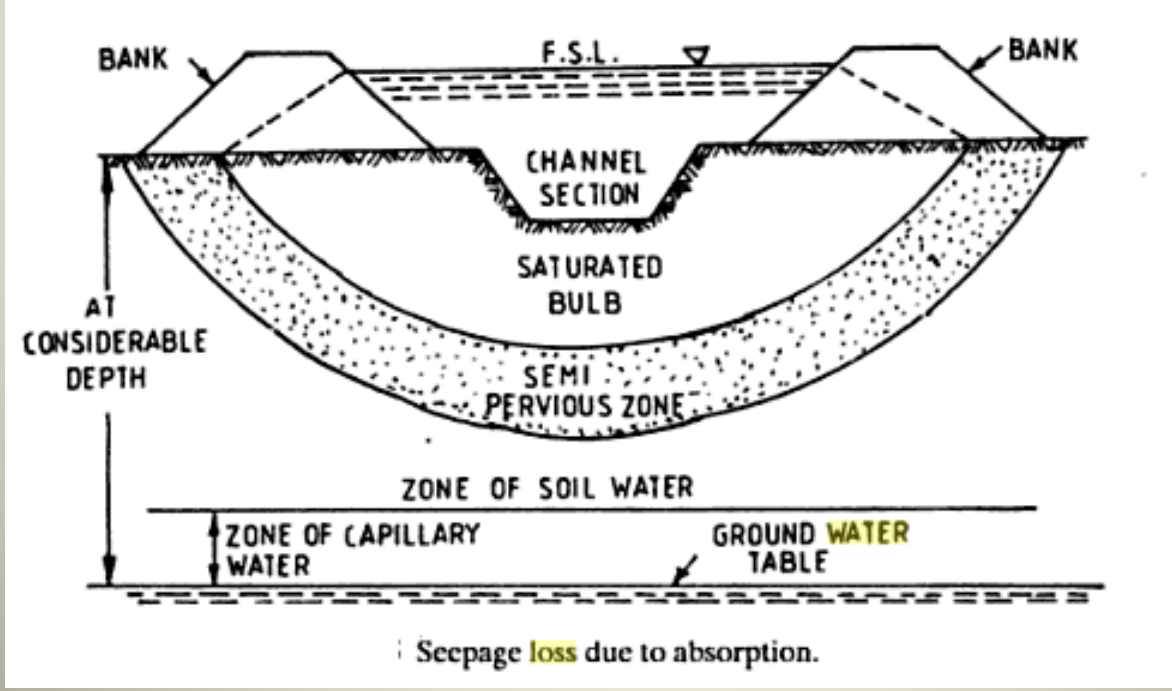


Seepage loss due to absorption.

Seepage Loss

Absorption:

- Thus, there exists an unsaturated soil zone between two saturated zones.
- This result in seepage loss.



Seepage loss due to absorption.

Canal Lining

Pranamesh Chakraborty

Advantages of Lining

- **Water Conservation**: Lining a canal results in reduction in water losses, as water losses in unlined irrigation canals can be high.

- **No seepage of water into 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.

Advantages of Lining (Contd.)

➢ **Reduced canal dimensions:** The 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 . Therefore, with the higher velocity, the canal cross-section for a lined canal can be smaller than that of an unlined canal.

➢ **Reduced maintenance**: Maintenance costs for the following issues are eliminated using lining of canals.

- Periodical removal of silt deposited on the beds and sides of canals.
- Removal of weeds and water canals.
- Minor repairs like plugging of cracks, uneven settlements of banks, etc.

Types of lining

Hard Surface Lining

- Cast Insitu Cement Concrete Lining
- Shotcrete or Plastic Lining
- Cement Concrete Tile Lining or Brick Lining
- Asphaltic Concrete Lining
- Boulder Lining

Earth Type Lining

- Compacted Earth Lining
- Soil Cement Lining

Pranamesh Chakraborty

Cast In-Situ Concrete Lining

Thank You