SYLLABUS

UNIT - V

Canal systems: alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels, alluvial channels. canal outlets: non-modular, semi modular and modular outlets. Canal outlets non-modular, semi-modular and modular outlets. Waterlogging: causes, effects and remedial measures. Lining of Canals-Types of Lining-Advantages and disadvantages. Drainage of irrigated lands- necessity, methods.

CANAL

A canal is an artificial channel, generally trapezoidal in shape constructed on the ground to carry water to the fields either from the river (or) tank (or) reservoir.

CLASSIFICATION OF CANALS

Classification of Canals based on Different Factors

A canal is an artificial channel constructed to convey water from rivers, reservoirs, etc. for several purposes like power generation, navigation, irrigation, etc. Canals are classified into different types based on factors such as nature of supply source, functions, type of boundary surface, financial output, discharge capacity and alignment of the canal.

Classification of Canals based on Different Factors

Canals are classified into different types based on factors which are as follows:

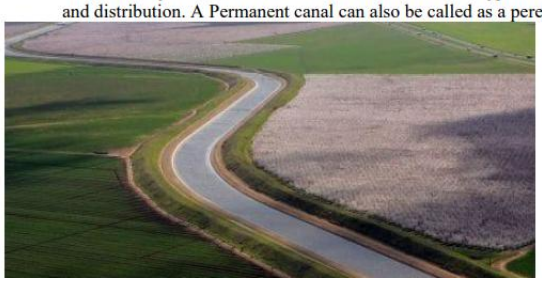
1. Based on the nature of the supply source
2. Based on functions
3. Based on the type of boundary surface soil
4. Based on the financial output
5. Based on discharge
6. Based on canal alignment

Based on the Nature of Supply Source

1. Permanent Canal
2. Inundation Canal

1. Permanent Canal

A Permanent canal is a type of canal in which water is available throughout the year. This type of canal is generally directed from a permanent source of supply water bodies. Several Permanent hydraulic structures are constructed in this type of canal for water regulation and distribution. A Permanent canal can also be called as a perennial canal.



2. Inundation Canal

Inundation canal is a type of canal in which water is available only during the flood periods. These type of canals are taken off from rivers to control the water level in rivers during floods. A canal head regulator is provided to regulate the flow into the canal.

Based on Functions of Canal

1. Irrigation canal
2. Power canal
3. Feeder canal
4. Carrier canal
5. Navigation canal

1. Irrigation canal

A canal aligned along the boundaries of cultivatable areas in order to supply water for the purpose of agriculture is said to be an irrigation canal.

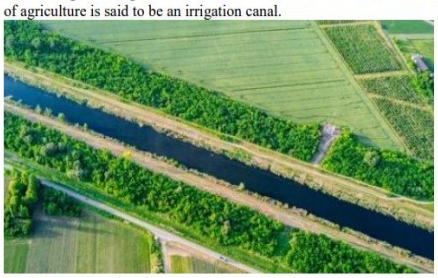


Fig 2: Irrigation Canal

2. Power canal

A canal constructed especially for the generation of hydraulic power is termed as power canal.

Fig 3: Power Canal of Lake Tekapo, Newzeland

3. Feeder canal

As the name says, a feeder canal is constructed to feed two or more other canals or branch canals.

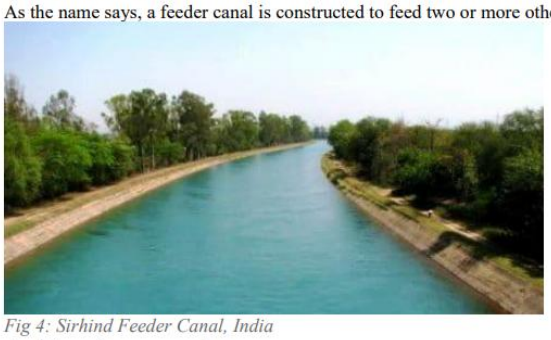


Fig 4: Sirhind Feeder Canal, India

4. Carrier canal

A carrier canal is multi-function canal which serves the purposes of both irrigation canal and feeder canal. It means the carrier canal feeds the other canals as well as provides water for direct irrigation.

Fig 5: Carrier Canal

5. Navigation canal

A canal which is constructed especially for navigational purposes is known as navigation canal. The water level required in a navigation canal is generally a lot higher to accommodate large ships, vessels, etc.

Fig 6: Panama Navigation Canal, Panama

Based on Type of Boundary Surface of Canal

1. Alluvial canal
2. Non-alluvial canal
3. Rigid Surface canal

1. Alluvial canal

If the canal is excavated in alluvial soils such as silt, sand, gravel, etc. then it is said to be an alluvial canal.

Fig 7: Alluvial Canal

2. Non-alluvial canal

If the boundary surface of the canal is of non-alluvial soils such as loam, clay, rock, etc. then it is said to be a non-alluvial canal.

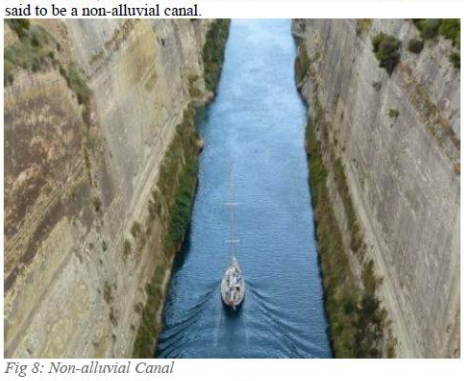


Fig 8: Non-alluvial Canal

3. Rigid Surface canal

Rigid surface canals also come under non-alluvial canals but here the boundary surface of the canal is lined artificially with a hard layer of lining material such as cement, concrete, stones, etc.

Fig 9: Rigid Surface Canal or Lined Canal

Based on Financial Output

1. Protective canal
2. Productive canal

1. Protective Canal

Protective canals are relief work projects which are constructed to protect a particular area from the shortage of water. The main objective of a protective canal is to fulfill the requirements of cultivators during the period of famine.

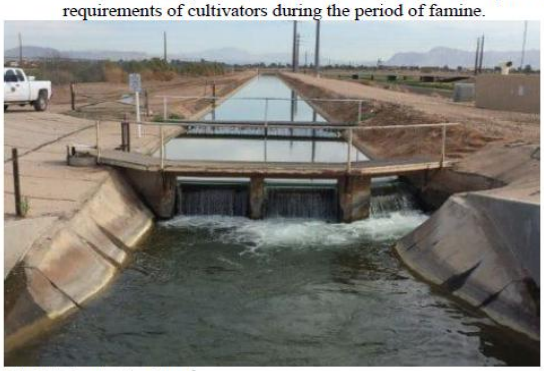


Fig 10: Protective Canal

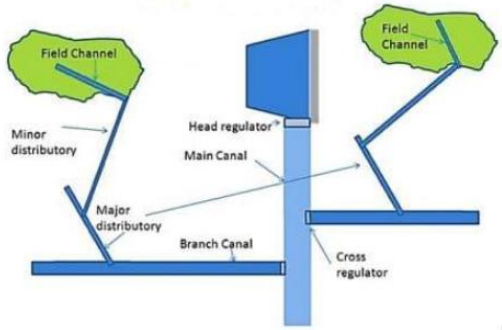


Fig 12: Canal Classification based on Discharge

1. Main canal

The main canal takes off directly from a river or reservoir. It carries water in large amounts to feed the branch and distributary canals. Due to conveying of very high discharge through the main canal it is not recommended to do direct irrigation from it.

2. Branch Canal

The branch canal takes off from main canals at regular intervals. These canals supply water to major and minor distributary canals. The discharge of the branch canal is generally over 5 m^3/sec. In the case of branch canals also, direct irrigation is not recommended unless their water carrying capacity is very low.

3. Major Distributary Canal

Major distributary canal takes off from the branch canal or in some cases from the main canal. They supply water to minor distributaries and field channels. A canal is said to be major distributary when its discharge lies between 0.25 to 5 m^3/sec.

2. Productive Canal

Productive canals are those which will produce enough revenue for its maintenance and runni costs and also to recover the initial investment made on the construction of the canal. It is said be good if it recovers 6% of its initial investment per annum.

Fig 11: Productive Canal, South-North Water Transfer Project, China

Based on Discharge

1. Main canal
2. Branch canal
3. Major distributary canal
4. Minor distributary canal
5. Field canal

4. Minor Distributary Canal

Minor distributary canal takes off from major distributaries and sometimes directly from branch canals depending upon the discharge of canals. Their discharge is generally below 0.25 m^3/sec. These canals supply water to the field channels.

5. Field Channels

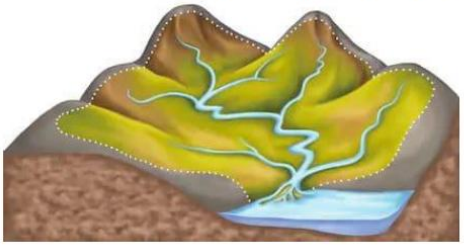
Field channels also known as watercourses are small channels excavated by cultivators in the irrigation field. These channels are fed by the distributary canals and branch canals through canal outlets.

Based on Canal Alignment

1. Ridge canal
2. Contour canal
3. Side-slope canal

1. Ridge Canal

A canal aligned along the ridgeline or watershed line of an area is said to be ridge canal or watershed canal. Since it is running at the peak altitude of the area, irrigation on both sides of the canal up to a larger extent of the area is possible. There is no interception of natural drains on ridge lines hence, no cross drainage works are required for this type of canal.



2. Contour Canal

A canal aligned roughly parallel to the contours of the area is called a contour canal. This type of canal can be seen in hilly regions. Since it is parallel to the contour line, the ground on one side of the canal is higher and hence irrigation is possible only on the other side of the canal. A contour canal has to pass the drainage and hence cross drainage works are required to be provided.

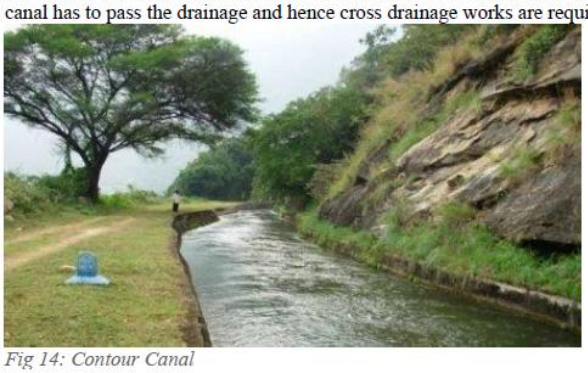


Fig 14: Contour Canal

3. Side-slope Canal

A canal aligned nearly perpendicular to the contour of the area is called a side-slope canal. It is located neither on the ridgeline nor on the valley line but is approximately in between them. It is parallel to the natural drainage line and hence no cross drainage works are required. The bed slope of side slope canal is very steep.

CANAL LINING

WATERLOGGING

Waterlogging, the saturation of soil with water, is caused by poor drainage, over-irrigation, and canal seepage. Its effects include reduced plant growth due to oxygen-deprived roots, soil salinity, increased weed and disease growth, and difficulties with cultivation. Remedial measures focus on improving drainage, controlling water sources, and managing crops, such as constructing drainage systems, lining canals, practicing crop rotation, and optimizing irrigation.

Causes of Waterlogging

- **Poor drainage:** Inadequate natural or artificial drainage systems cause water to accumulate.
- **Excessive irrigation:** Over-irrigation saturates the soil and raises the water table.
- **Canal seepage:** Water seeping from unlined canals is a major cause of waterlogging in many areas.
- **Interruption of natural flow:** Obstruction of natural water flow patterns can lead to water pooling.
- **High water table:** A naturally high water table can cause soil pores to become saturated.

Effects of Waterlogging

- **Reduced plant growth:** Lack of oxygen for plant roots due to saturated soil kills beneficial bacteria and inhibits nutrient uptake.
- **Soil salinity:** Harmful salts are drawn to the soil's surface, reducing fertility and making the land infertile.
- **Increased disease and weeds:** Waterlogged areas are breeding grounds for mosquitoes and favor the growth of water weeds.
- **Difficulty with cultivation:** Waterlogged soil becomes slushy, making it difficult to plow and cultivate.
- **Lowered soil temperature:** Waterlogging can lead to a drop in soil temperature, which may negatively affect plant growth.
- **Damage to infrastructure:** Dampness can weaken buildings and infrastructure.

Remedial Measures of Waterlogging

- **Improve drainage:** Install surface and subsurface drainage systems to remove excess water.
- **Reduce water infiltration:** Line canals to prevent seepage and build intercepting drains to block water from entering the area.
- **Manage irrigation:** Educate farmers on efficient water use and reduce irrigation intensity in vulnerable areas.
- **Implement crop rotation:** Plant a mix of crops with varying water requirements to help manage soil moisture and lower the water table.
- **Increase water outflow:** Use techniques like lift irrigation to lower the water table through methods like pumping from tube wells.
- **Improve natural drainage:** Clear and improve natural waterways to allow water to flow away more freely

DRAINAGE OF IRRIGATED LANDS

- It is the process of removing excess surface and sub-surface water from agricultural fields. To improve soil conditions, the crop growth.
- The excessive water is due to heavy rainfall or over irrigation
- The excess water causes waterlogging

Methods of Drainage System – Types of Field Drainage System

1. Surface Drainage

- This is designed primarily to remove excess water from the surface of soil profile.
- This can be done by developing slope in the land so that excess water drains by gravity.

Advantages of Surface Drainage

- Provision of surface drainage is cheap.
- The defects in the open drainage can be seen easily and rectified
- Effective in low permeability area.

Disadvantages in Surface Drainage System

- Considerable amount of land is wasted for open drains
- These drains cause hindrance to field preparation and intercultivation.
- The drains get silted and periodical desilting is necessary
- Weed growth in the drains is heavy and this has to be removed
- Open drains are damaged by rodents and farm animals.

2. Sub-Surface Drainage

- Sub surface drains are underground artificial channels through which excess water is made to flow through a suitable outlet.
- The purpose is to lower the ground water level below the root zone of the crop.

Advantages of Sub-Surface Drainage

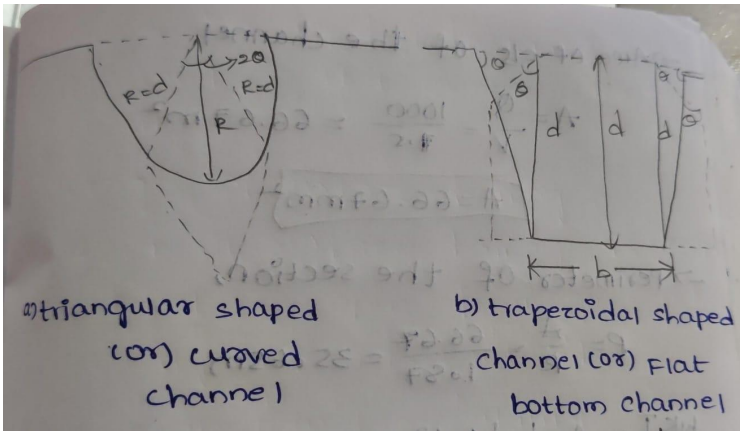
- There is no loss of cultivable land.
- No interference for field operation
- Maintenance cost is less
- Effectively drains sub soil and creates better soil environments.

Disadvantages of Sub-Surface Drainage

- Initial cost is high
- It requires constant attention
- It is effective for soils having low permeability

ESTIMATION ON DESIGN DISCHARGE

The procedure used for design of trapezoidal shaped channel is given below:



a) triangular shaped (or) curved channel

b) trapezoidal shaped channel (or) Flat bottom channel

i) Knowing limiting velocity V, the Rugosity co-efficient N, longitudinal slopes, and Hydraulic mean depth R, we apply mannings Equation

$$V = \frac{1}{N} R^{2/3} S^{1/2}$$

ii) Find the area of cross section from the continuity Equation

$$Q = A \times V$$

$$A = \frac{Q}{V}$$

iii) Find out the wetted perimetted of the section

$$P = \frac{A}{R}$$

iv) Also for the trapezoidal shape channel there area of cross section will be

$$A = bd + d^2\theta + d^2 \cot\theta$$

(or)

$$A = bd + d^2(\theta + \cot\theta)$$

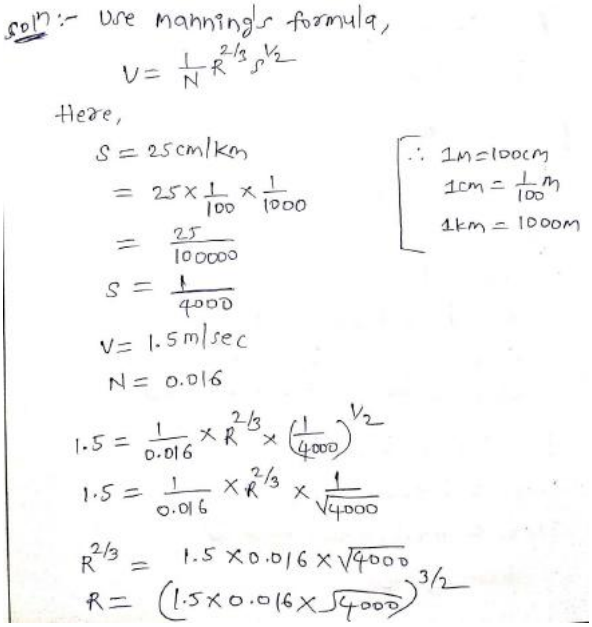
And wetted perimeter is

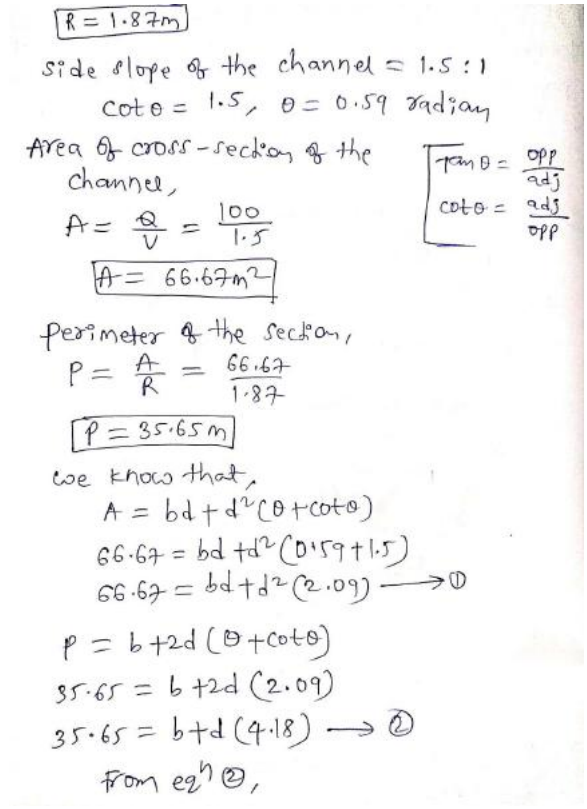
$$P = b + 2d(\theta + \cot\theta)$$

where, b = ~~wet~~ bed width

d = ~~wet~~ bed depth

Design a trapezoidal shape concrete lined to carry a discharge of 100 cumecs at a slope of 25cm/km. the side slopes of the channel are 1.5:1. The value of 'N' may be taken as 0.016. Assume the limiting velocity as 1.5m/sec.





$b = 35.65 - 4.18d$

'b' value substitute in eqn ①, we get

$66.67 = (35.65 - 4.18d)d + 2.09d^2$

$66.67 = 35.65d - 4.18d^2 + 2.09d^2$

$d^2 - 17.1d + 31.9 = 0$

$\boxed{d = 2.145m}$

$b = 35.65 - 4.18 \times 2.145$

$\boxed{b = 26.68m}$

∴ bed width = 26.68M

bed depth = 2.15m