# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**Introduction:**

- Canals one as old as irrigation and they date back to many centuries, particularly in India and Egypt.
- However, during these periods irrigation was restricted to smaller areas and these areas were fed by **Inundation Canals** of short length from a river.
- Therefore, proper design of canals is of great importance.
- Also it is most essential to select a most economical section of the canal.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

### CANALS:

### Definition of Canal:

- A canal is a passage for the flow of water, mainly under gravitational force. It is generally trapezoidal in shape constructed on the ground to carry water to the fields from a storage system like a tank or reservoir.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**TYPES OF CANALS:**

**Alluvial and Non – Alluvial Canals:**

- **Alluvial canals** are those constructed through alluvial soils, their bed and banks comprise of the same material that is being transported by the canal.
- Such a canal can be readily silted or scoured.
- These canals are designed using the Lacey's Regime Theory.
- Alluvial canals generally take off from a barrage or a weir.
- Such soils are available in Indo – Gang etic plains of North India.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

## CANALS:

## TYPES OF CANALS:

### Alluvial and Non – Alluvial Canals:

- **Non – alluvial canals** are those constructed through hard soils or fresh rocks.
- These types of canals are stable, usually designed for higher velocities and can withstand erosion.
- They are designed using Manning's, Chezy's and Kutter's equations.
- Non – alluvial canals take off from reservoirs. Such soils are usually found in central and South India.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**TYPES OF CANALS:**

**Permanent and Inundation Canals:**

- **Permanent canals** are the canals fed by a permanent source of supply.
- They are also known as perennial canals.
- They are well graded channels and are provided with permanent regulation and distribution works.
- **Inundation canals** are the canals which usually draw their supplies during monsoon.
- These canals are not provided with any head works for diverting the water but are provided with canal head regulators.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**TYPES OF CANALS:**

**Lined and Unlined Canals:**

- A **lined canal** is on which is provided with a protective covering on the bed and sides, in order to prevent seepage of water and also to minimize the erosion.
- An **unlined canal** is one which has its bed and sides made up of soil through which it is constructed and no protective covering is provided.
- The velocity in such a canal is maintained low to overcome the risk of erosion.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**CLASSIFICATION OF CANALS BASED ON DISCHARGE:**

**Main Canal:** it is the principal canal of the network, it generally takes off from the reservoir. Such a canal carries heavy discharge and is not used for direct irrigation. Main canal is intended to supply water to the branch canal and major distributary.

**Branch Canal:** these are canals branching off from the main canal in either direction taking off at regular intervals. The discharge in such canals will be more than 5 cumecs. The main function of a branch canal is to supply water to the major and minor distributaries.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**CLASSIFICATION OF CANALS BASED ON DISCHARGE:**

**Major Distributary:** takes off from branch canal. It supplies water for irrigation to the fields through the outlets provided along its length. The discharge inn such a canal varies from 0.25 to 5 cumecs.

**Minor Distributary:** it is a canal taking off from the major distributary or a branch canal. The discharge carrying capacity of such a channel will be less than 0.25 cumec.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

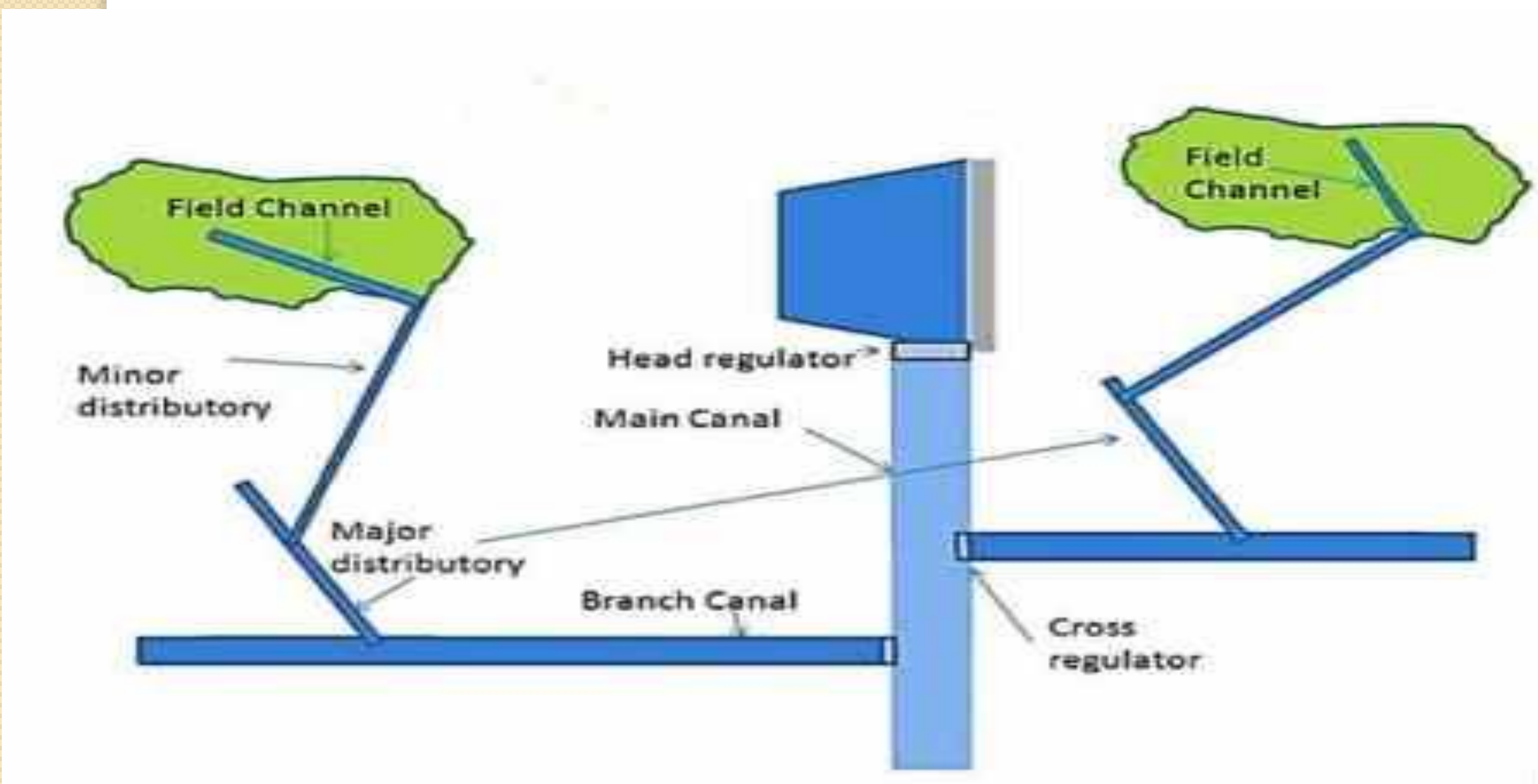
**CLASSIFICATION OF CANALS BASED ON DISCHARGE:**

**Field Channel or Minor:** it is a canal supplying water to the fields directly. It takes of from a major or a minor distributary. These canals even though constructed by the irrigation department, have to be maintained and regulated by the framer. The discharge in this canal will be less than 0.1 cumec

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**



# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**CLASSIFICATION OF CANALS BASED ON THEIR ALIGNMENT:**

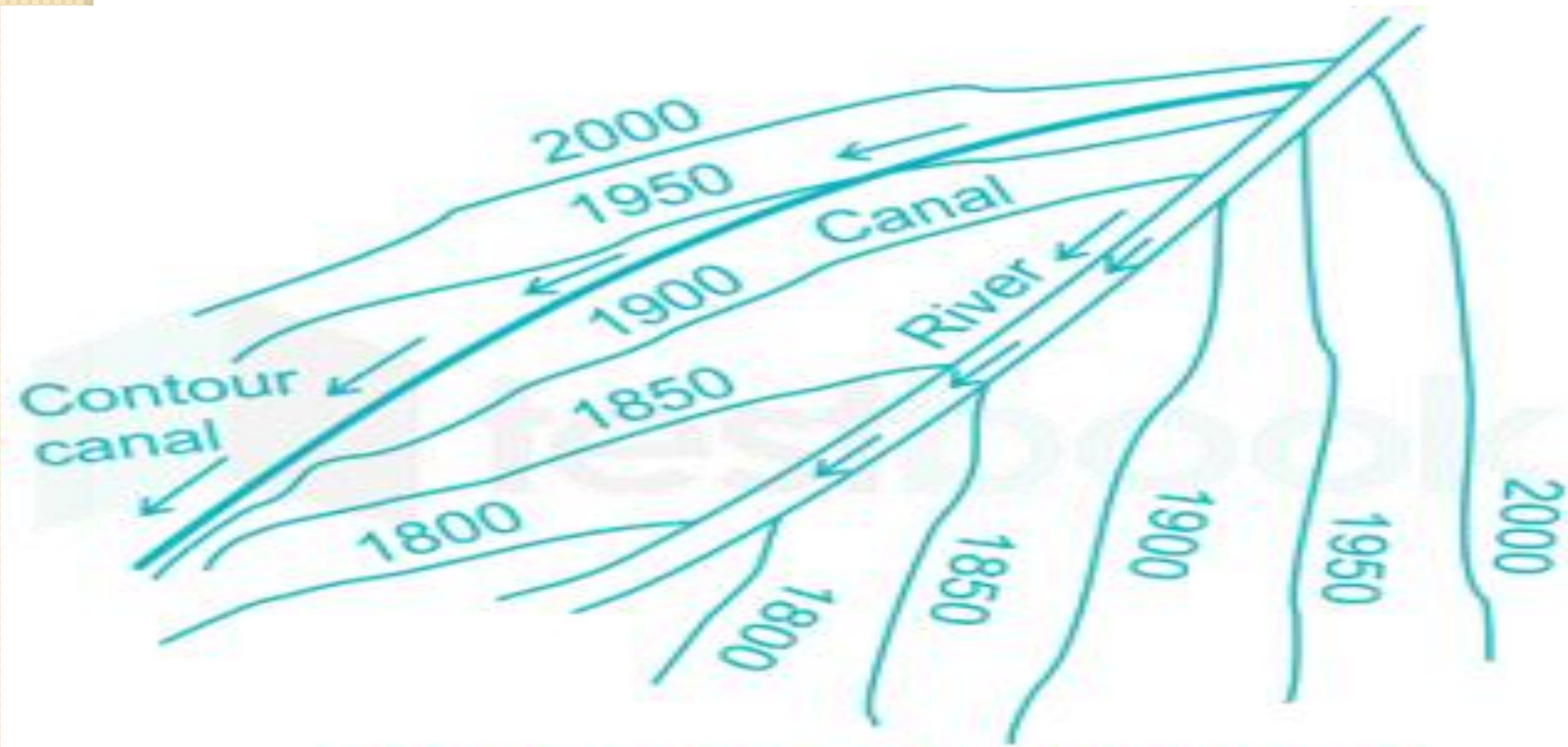
**Contour Canal:**

- It is a canal aligned nearly parallel to the contours of the country as shown in figure.
- It is also known as a single bank canal.
- A contour canal can irrigate only on one side.
- The contour canal does not follow the same contour all along its length due to the fact that some bed slope is necessary for the flow of water under gravity.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**




Alignment of a contour canal

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**CLASSIFICATION OF CANALS BASED ON THEIR ALIGNMENT:**

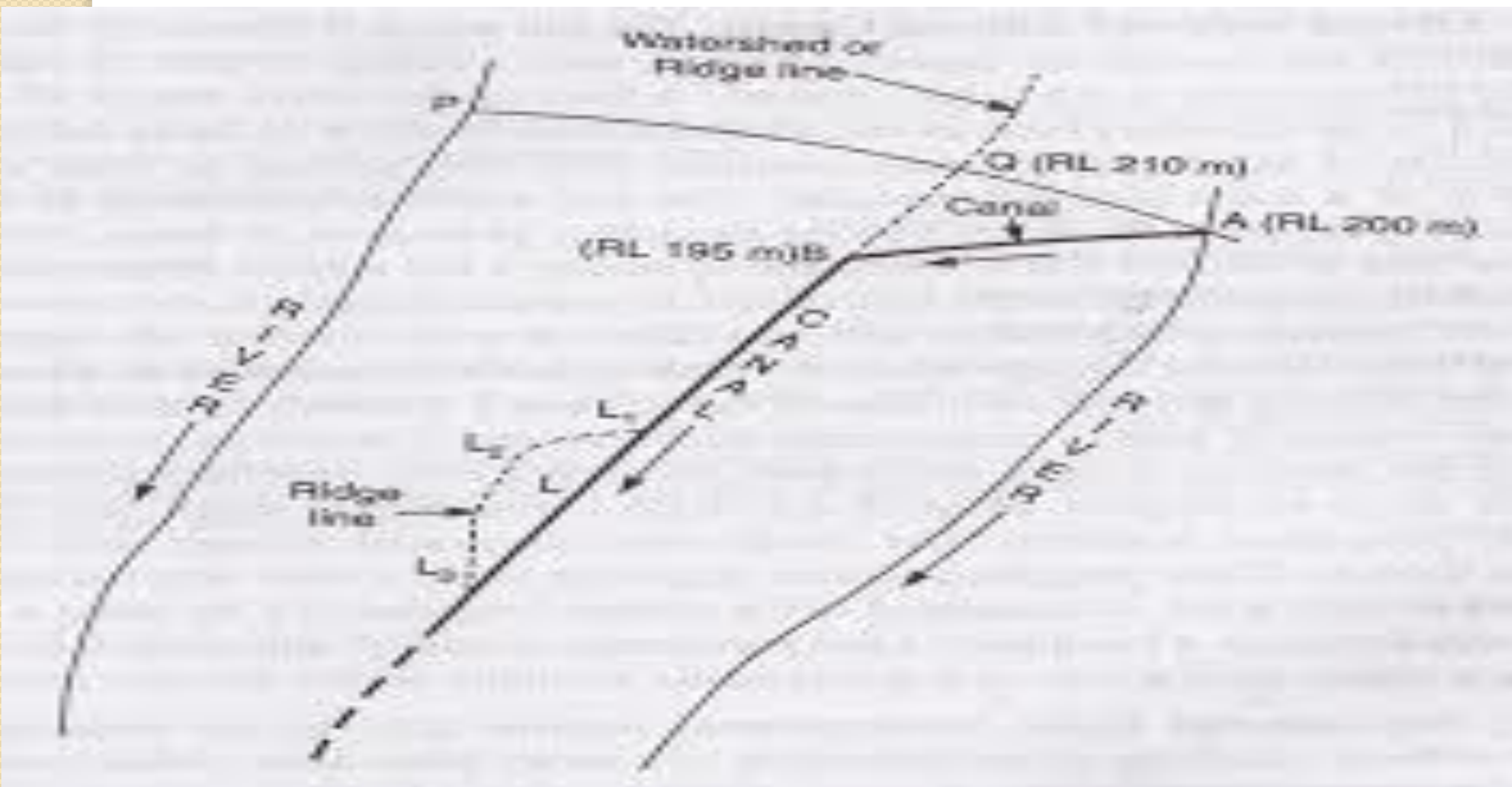
**Water Shed Canal or Ridge Canal:**

- It is a canal which is aligned along the ridge or the natural water shed line as shown in figure.
- Such a canal does not need any cross drainage works.
- Cost analysis reveals that the ridge canals are most economical.
- Sometimes it may be necessary to abandon the ridge line in order to bypass habitations such as villages, towns etc. situated on the water shed.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**



# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**CLASSIFICATION OF CANALS BASED ON THEIR ALIGNMENT:**

**Side Slope Canal:**

- This type of a canal is aligned roughly at right angles to the contours of the country.
- Hence it runs approximately parallel to the natural drainage, thereby cross drainage works are avoided.
- The main disadvantages of such a canal is that it has very steep bed slope of the ground is at right angles to the contours of the country.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

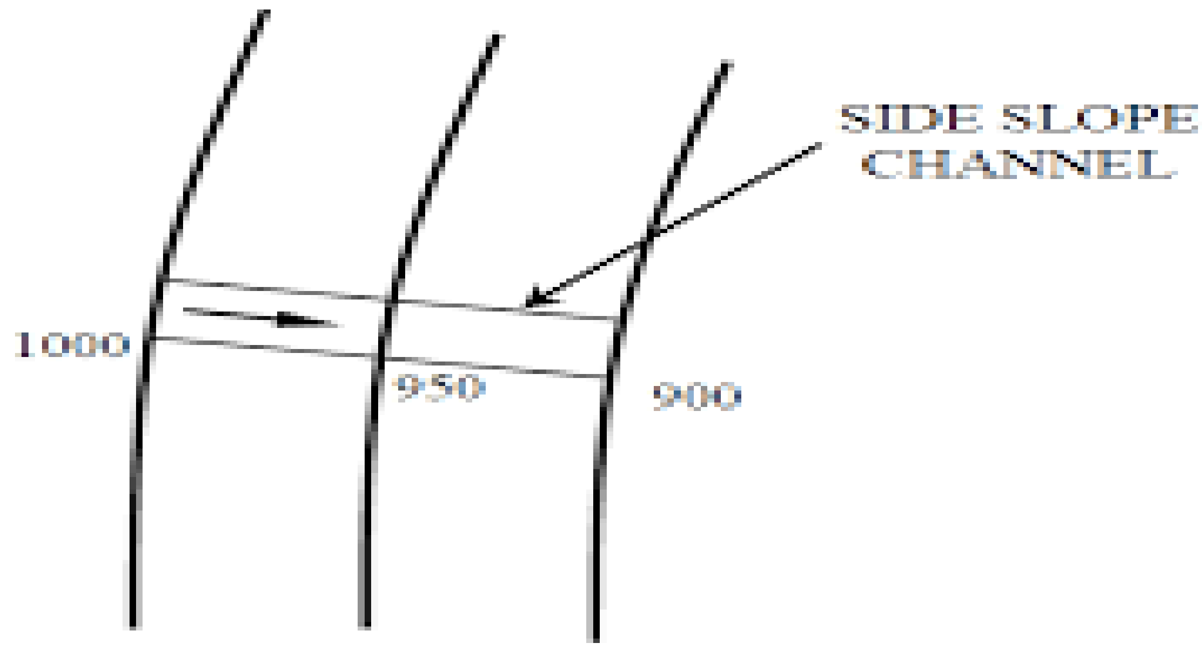



**Fig: Alignment of a side slope canal**

# Module – 5: Canals and Reservoirs

## CANALS:

## CLASSIFICATION OF CANALS BASED ON THEIR ALIGNMENT:

### Detour Canal:

- A contour canal may have to cross number of C D works.
- A detour canal envisages adoption of a lengthy alignment so that the cost of construction of the canal and its related hydraulic structures are a minimum.
- However, the lengthy alignment of a detour canal may result in loss of command and increased number of C D works.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**CONSIDERATION FOR ALIGNMENT OF A CANAL:**

- The alignment should be such that it ensures the most economical way of distributing water to the land, has the maximum commanded area and minimum number of drainage work.
- The alignment on a watershed being the most economical is preferred.
- The length of the main canal from the point, where it takes off from river to a point where it mounts on a watershed should be minimum.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Water Requirement of a Crop:** it can be defined as the quantity of water required by a crop in a given period of time for normal growth under field conditions.

**Total Water Requirement:** it can be defined as the quantity of water needed for potential production per unit of land for sustained production and is then sum of consumptive use, application conveyance losses and other special needs.

**Unit Water Requirement:** it is defined as the weight of water actually used by the plants or crops in producing unit weight of dry matter.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Optimum Moisture Percentage:** it is that moisture corresponding to which optimum growth of plant takes place.

**Readily available Moisture:** it is that moisture which is easily extracted by the plants and is approximately equal to 75% of the available moisture.

**Available Moisture:** it is the difference in water content of the soil between field capacity and permanent wilting.

**Soil Moisture Deficiency or Field Moisture Deficiency:** it is the water required to bring the soil moisture content of the soil to its field capacity.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Frequency of Irrigation:** it depends on the amount of readily available moisture in the root zone of the plant and the rate of consumptive use, If $C_u$ is the rate of consumptive use expressed in terms of depth of moisture lost from the soil per day, then frequency of irrigation.

$$f_w = \{d_w / C_w\}, \text{ } f_w \text{ is expressed in days}$$

**Arid and Semi-Arid Region:** the area where irrigation is a must for agriculture is known as arid region. The area in which inferior crops can be grown without irrigation is known as semi-arid region.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Gross Commanded Area (GCA):** it is the total area enclosed between the imaginary boundaries line up to which certain irrigation channel is capable of supplying water for irrigation purposes. It includes unculturable areas like small drainages, ponds, forests, buildings, roads, barren land plus the fields on which the crops are grown or can be grown.

**Culturable Commanded Area (CCA):** it is the land on which crops can be grown satisfactorily. CCA can be:

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Culturable Cultivated Area:** it is the area of the land on which cultivation practices are performed in the present time.

**Culturable Uncultivated Area:** it is the area on which cultivation can be done if thought of it, but presently not cultivated for various reasons.

CCA = {GCA – Unculturable Area of GCA}

**Intensity of Irrigation:** it is the ratio of irrigated land at a time in one crop season to the culturable command area.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Rotation of Crops:** it means that nature of the crop sown in a particular field is changed year after year.

**Crop Ratio:** it is the ratio of the areas under the crops of two main seasons.

**Crop Season:** it is part of the year during which a particular crop is grown.

**Rabi Crop Season:** are also known as winter crops. Normally these crops are sown in the month of October and are harvested by the end of March.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Kharif Crop Season:** are also known as monsoon crops. Normally these crops are sown in the month of April and are harvested by the end of September.

**Hot Weather Crops:** these are the crops sown in February and harvested in May or June.

**Dry Crops:** these are the crops which are ordinarily grown without irrigation, but utilizing the moisture stored in the soil during rainy season.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Wet Crops:** these are the crops which are grown with irrigation.

**Cash Crops:** these are the crops that can be encashed in the market.

**Crop Period:** it is the total time in days that has elapsed between the sowing of the crop and its harvesting. Hence crop period is the total time during which the crop remains in the field.

**Base period:** it is the total time in days between the first watering done for the preparation of the land sowing of a crop and the last watering done before its harvesting.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Overlap Allowance:** it is possible that crops of one season may extend into the other season. Hence both the crops need water simultaneously. This extra discharge of water provided for this reason is known as overlap allowance.

**Time Factor:** it is the ratio of the number of days the canal has actually run to the number of days the canal was supposed to run for a particular period of watering as per calculations in the design.

**Capacity Factor:** it is the ratio of the average discharge of a canal at any point to the full supply discharge of the canal at the same point.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**DEFINITIONS:**

**Berms:** they are narrow strip of land left at the ground level between the inner toe of the bank and top edge of cutting.

**Free Board:** is the gap or the margin of height between FSL and top of the bank.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**KENNEDY'S THEORY:**

- The salient features of Kennedy's theory for the design of earthen channels based on the critical velocity concept and its limitations.
- Kennedy selected a number of sites in upper Bari Doab canal system for carrying out investigations about velocity and depth of the channel.
- As the sites selected by him were more than thirty years old channel.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**KENNEDY'S THEORY:**

- As the sites selected by him were more than thirty years old they were assumed to be flowing with non-silting, non-scouring velocity.

**Kennedy's investigation revealed the following**:

- The silt is kept in suspension due to eddies, also the silt supporting power is therefore proportional to the bed width of the stream and not it's wetted perimeter.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**KENNEDY'S THEORY:**

- A velocity sufficient to generate these eddies keeps the sediment in suspension, thereby avoiding sitting up of the channel.
- He designated this velocity as the critical velocity [$V_o$] defined as the mean velocity which just keeps the channel free from silting and scouring.
- Hence established a relation between critical velocity to the depth of flowing water [y] as,

$$V_o = 0.55\, y^{0.64}$$

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

## CANALS:

## KENNEDY'S THEORY:

- However, Kennedy realized the importance of silt grade on critical velocity and introduce a factors m known as critical velocity ratio in equation there by it can be rewritten as,

$$V = 0.55\ m\ y^{0.64}$$

Where m = critical velocity = $\{V / V_o\}$

- Kennedy and Kutter's equation for finding the mean velocity of flow (V).

$$V = \left\{ \frac{23 + \frac{1}{N} + \frac{0.00155}{S}}{1 + \left[23 + \frac{0.00155}{S}\right] + \frac{N}{\sqrt{R}}} \right\} \sqrt{R}$$

# Module – 5: Canals and Reservoirs

## CANALS:

## KENNEDY'S THEORY:

Where

- N = Manning's Rugosity Coefficient
- R = Hydraulic Radius = [Area / Wetted Perimeter]
- S = Longitudinal slope of the channel bed

# Module – 5: Canals and Reservoirs

## CANALS:

## KENNEDY’S THEORY:

**Limitations of Kennedy’s Theory are:**

- Limitations of Kutter’s equation become incorporated in Kennedy’s design procedure.
- Kennedy did not give any equation for the bed slope of the channel, it is decided and based on the slope of the ground available.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

## CANALS:

## KENNEDY'S THEORY:

**Design Procedure:**

**Case 1:** given, discharge (Q), water surface slope (S), coefficient of rugosity (N) and critical velocity ratio ($V_o$).

**Procedure:**

- Assume a trail depth y.
- Calculate the velocity $V_o$ from the formula, $V_o = 0.55\, y^{0.64}$.
- Calculate the area of cross section (A) from the continuity equation, $A = \{Q / V_o\}$.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**KENNEDY'S THEORY:**

- Calculate the bed width B from the relation, $A = By + ny^2$. Where the side slopes n is assumed as 0.5.
- Calculate the wetted perimeter P from the relation, $P = B + 2y\sqrt{(1 + n^2)}$ and hence calculate the hydraulic radius $R = \{A/P\}$.
- Calculate the mean velocity V from the Kutter's formula.

$$V = \left\{ \frac{23 + \frac{1}{N} + \frac{0.00155}{S}}{1 + \left[23 + \frac{0.00155}{S}\right] + \frac{N}{\sqrt{R}}} \right\} \sqrt{RS}$$

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**KENNEDY'S THEORY:**

- If the values of the velocities as given by equations are identical, then the assumed depth [y] is correct, otherwise the procedure has to be repeated.

**Case 2:** given, Q, N, m and B/y ratio form wood's table.

**Procedure:**

- Calculate A in terms of y.

$$\text{Let } \{B/y\} = x \text{ therefore, } B = xy$$

$$A = By + ny^2 = xy^2 + \{y^2 / 2\}$$

$$A = y^2 (x + 0.5)$$

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**KENNEDY'S THEORY:**

- Calculate the velocity V from the Kennedy's equation, $V = 0.55\, m\, y^{0.64}$.
- Substituting the values of A and V in the continuity equation, calculate the value of y i.e.

$$Q = AV = y^2 (x + 0.5) \times 0.55\, m\, y^{0.64}$$

$$y = \left\{\frac{Q}{0.55\, m\, (x+0.5)}\right\}^{\frac{1}{2.64}}$$

- Knowing Y calculate the bed width B and the hydraulic radius R from the relations B = n y and R = {A / P}.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

## CANALS:

## KENNEDY'S THEORY:

- Calculate the velocity from the Kennedy's equation, $V = 0.55\ m\ y^{0.64}$.
- Knowing V and R, determine the slope S from the Kutter's equation by trial and error.

$$V = \left\{ \frac{23 + \frac{1}{N} + \frac{0.00155}{S}}{1 + \left[23 + \frac{0.00155}{S}\right] + \frac{N}{\sqrt{R}}} \right\} \sqrt{RS}$$

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

## CANALS:

## KENNEDY'S THEORY:

### Draw Backs of Kennedy's Theory:

- It ignores the importance of bed width and depth ratio.
- The draw backs of Kutter's equation are reflected in the Kennedy's theory.
- Adaptation of an arbitrary N value of 0.0225 is incorrect.
- Kennedys' theory aims at the design of average regime channel.
- Kennedy has not given an equation for the slope.
- Silt concentration and bed load are not considered.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**KENNEDY'S THEORY:**

**Draw Backs of Kennedy's Theory:**

- Silt grade and silt charge is not defined.
- Kennedy's procedure is by trial and error only, which means for any value of y there can be number values of B, i.e. the channel need not be an economical section.
- Kennedy simply mentioned the critical velocity ratio (CVR) m, but did not give a procedure to measure it.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**LACEY'S THEORY:**

**Regime Channel:** according to Lacey a regime channel is a stable channel transporting a regime silt charge. A channel is said to be in regime if it flows in incoherent unlimited alluvium of the same character as that transported and the silt grade and silt charge are all constant.

**Incoherent Alluvium:** it is a loosely composed granular soil which can be scoured with the same ease with which it is deposited.

**Regime Silt Charge:** it is the minimum transported load consistent with fully active bed.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**LACEY'S THEORY:**

**Regime Silt Grade:** this indicates the range between the small and big particles.

**Regime Conditions:** an irrigation channel is said to be in regime when the following conditions are satisfied:

- The channel is flowing in unlimited incoherent alluvium of the same character as that transported.
- Silt grade and silt charge is constant.
- Discharge is constant.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

## CANALS:

## LACEY'S THEORY:

**Initial Regime:** it is the state of the channel that has formed its section only and not yet secured the longitudinal slope.

**Final Regime:** it is the state of the channel after attaining its section and the longitudinal slope.

**Permanent Regime:** this is stage when the channel is protected on the bed and sides with protecting material, so that neither the cross section changes nor its longitudinal slope.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**LACEY'S THEORY:**

**Design Procedure:**

- Calculate the silt factor F from the equation, $F = 1.76\sqrt{m}$, m = mean particle size in mm.
- Calculate the average velocity from the equation, $V = \{\frac{Qf^2}{140}\}^{\frac{1}{6}}$
- Calculate the area of cross section of the channel from the continuity equation, $A = \{Q / V\}$.
- Calculate the wetted perimeters of the channel from the equation, $P = 4.75\sqrt{Q}$.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**LACEY'S THEORY:**

**Design Procedure:**

- Knowing A and P and assuming the side slopes of the channel as 0.5H to 1V, calculate the bed with (B) and depth of flow (y) from the relations
- $A = By + ny^2$ and $P = B + 2y$, n = 0.5 side slope
- Calculate the hydraulic radius, $R = \{A / P\}$.
- Also calculate the hydraulic radius R from the equation, $R = \{5 /2\} \times \{V^2 / f\}$.
- Calculate the bed slope S from the equation, $S = \{f^{5/3} / 3340\ Q^{1/6}\}$.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**LACEY'S THEORY:**

**Draw Backs of Lacey's Theory:**

- The characteristics of regime channel are not precisely defined.
- The true regime conditions as given by Lacey are just theoretical and may not be achieved in practice.
- The value of silt factor f may be different for the bed and sides, hence the derivation of various equations by considering f alone is not satisfactory.
- Lacey's theory does not consider the concentration of silt.

## Module – 5: Canals and Reservoirs

# CANALS:

# LACEY'S THEORY:

### Draw Backs of Lacey's Theory:

- According to Lacey's a regime channel is inherently free from external shock, however a regime channel carries sediment and will normally have a changing pattern of bed ripple transportations, this statement is unlikely to be correct.
- Silt charge and silt grade are not properly defined by Lacey.
- Lacey's equations do not include silt charge.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**CANALS:**

**COMPARISON BETWEEN LACEY'S THEORY AND KENNEDY'S THEORY:**

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

### RESERVOIRS:

**Introduction:**

- Construction of a dam, barrage across a river results is the formation of a reservoir, which is nothing but huge storage of water.
- This water is stored during the period when the inflow is in excess of the demand on the downstream side.
- The water stored may be used for irrigation, hydroelectric power, domestic usage, industrial usage, recreation and so on.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

### RESERVOIRS:

**Introduction:**

- Apart from the said factors a reservoir helps in controlling the floods, improvement in climate, reduction in river pollution, check on spread of diseases due to improved water supply and sanitation.
- Finally reduction in the river section of river cross section thereby considerable area is made available for cultivation.
- On the other hand formation of a reservoir would have disadvantages like: submergence of fertile lands, displacement of large population, possible advice effects on the ecology of the area, entrapping of fertile sand and displacement of wild life.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**Definition:**

- A reservoir is a large body of water stored on the upstream side of a dam constructed across a river. Therefore, a reservoir and a dam exist together.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**CLASSIFICATION OF RESERVOIRS:**

**Storage Reservoir:**

- A storage reservoir also known as conservation reservoir, mainly servers the purpose of conserving water.
- Essentially water is stored during monsoon and released gradually for intended purpose like irrigation, water supply or hydropower.
- Such a reservoir also helps in moderating the floods and reducing the flood damage to a certain extent.
- However, it is not designed as a flood control reservoir.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**CLASSIFICATION OF RESERVOIRS:**

**Flood Control Reservoir:**

- A flood control reservoir serves the purpose of flood controlling by protecting the areas on the downstream side.
- It is also known as flood mitigation reservoir or flood mitigation or flood protection reservoir.
- Flood water from this type of reservoir is discharges or let out till the outflow reaches the safe capacity of the channel.
- When once the safe capacity is exceeded flood water is stored in the reservoir.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**CLASSIFICATION OF RESERVOIRS:**

**Multipurpose Reservoir:**

- A multipurpose reservoir is designed and constructed to serve more than one purpose.
- Most of the reservoirs are multipurpose reservoirs.

**Distribution Reservoir:**

- A distribution reservoir is a small storage reservoir which helps in storing water during period of lean demand and supplies during the period of high demand.
- Such type of reservoir so as take care of water supply for irrigation.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**INVESTIGATION FOR RESERVOIR:**

**Engineering Investigations / Surveys:**

- Generally engineering surveys are conducted for the dam, the reservoir and their associated works.
- During this investigation topographic survey of the area is carried out and the contour plan is prepared.
- The horizontal control is usually provided by triangulation survey and vertical control by precise levelling.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

# RESERVOIRS:

## INVESTIGATION FOR RESERVOIR:

### Engineering Investigations / Surveys:

- A the **dam site,** very accurate triangulation survey is conducted and a contour plan to a scale of 1:250 or 1:500 is generally prepared with contour intervals in the range of 1 to 2 m.
- Such a survey should cover an area up to 200m upstream, 400m downstream and for adequate width beyond the two abutments.
- For a **reservoir,** the contour plan is generally prepared to a scale of 1:15,000 with contour intervals between 2 to 3 m.

# Module – 5: Canals and Reservoirs

## RESERVOIRS:

### INVESTIGATION FOR RESERVOIR:

**Geological Investigations:**

- Suitability of foundation for the dam.
- Water tightness of the reservoir basis.
- Location of quarry sites for the construction.

**Hydrological Investigations:**

- To study the runoff pattern and to estimate yield.
- To determine the maximum discharge at the site.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**SELECTION OF SITE FOR A RESERVOIR:**

**Large Storage Capacity:** the topography of the proposed site should be such that the reservoir has large capacity for storing the water.

**Suitable Site for the Dam:** a suitable site for the proposed dam should be available on the downstream side of the reservoir, with very good foundation, narrow opening in the valley to provide minimum length of the dam and also the cost of construction should be minimum.

Module – 5: Canals and Reservoirs

# RESERVOIRS:

## SELECTION OF SITE FOR A RESERVOIR:

**Water Tightness of the Reservoir:** geology at the proposed reservoir site should be such that the entire reservoir basin is water tight. They should have granite, gneiss, schists, slates or shales etc.

**Good Hydrological Conditions:** the hydrological conditions of the river at the reservoir should give high yield. Evaporation, transpiration and percolation losses should be minimum.

Hydrology and Irrigation Engineering (18CV63)

# Module – 5: Canals and Reservoirs

## RESERVOIRS:

### SELECTION OF SITE FOR A RESERVOIR:

**Minimum Silt Inflow:** the life of reservoir is defined by the quantity of silt inflow, which menas that, if the silt inflow is large, the life would be less. Hence it is necessary to select the reservoir site at such a place, where the silt inflow is minimum.

**No Objectionable Minerals:** the proposed site should be free from soluble and objectionable salts, which may pollute the reservoir.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**STORAGE ZONES OF A RESERVOIR:**

**Live Storage or Useful Storage:** is that amount of water available or stored between the minimum pool level (LWL) and the full reservoir level (FRL). Minimum pool level or low water level is fixed after considering the minimum working head required for the efficient working of turbines.

**Surcharge Storage:** is the volume of water stored above the full reservoir level (FRL) up to the maximum water level (MWL).

# RESERVOIRS:

## STORAGE ZONES OF A RESERVOIR:

**Dead Storage:** is the volume of water held below the minimum pool level. This storage is not useful and hence cannot be used for any purpose under ordinary operating conditions.

**Bank Storage:** water stored in the banks of a river is known as bank storage. In most of the reservoirs the bank storage is small since the banks are generally impervious.

**Valley Storage:** is the volume of water held by the natural river channel in its valley up to the top of its banks before the construction of the reservoir.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

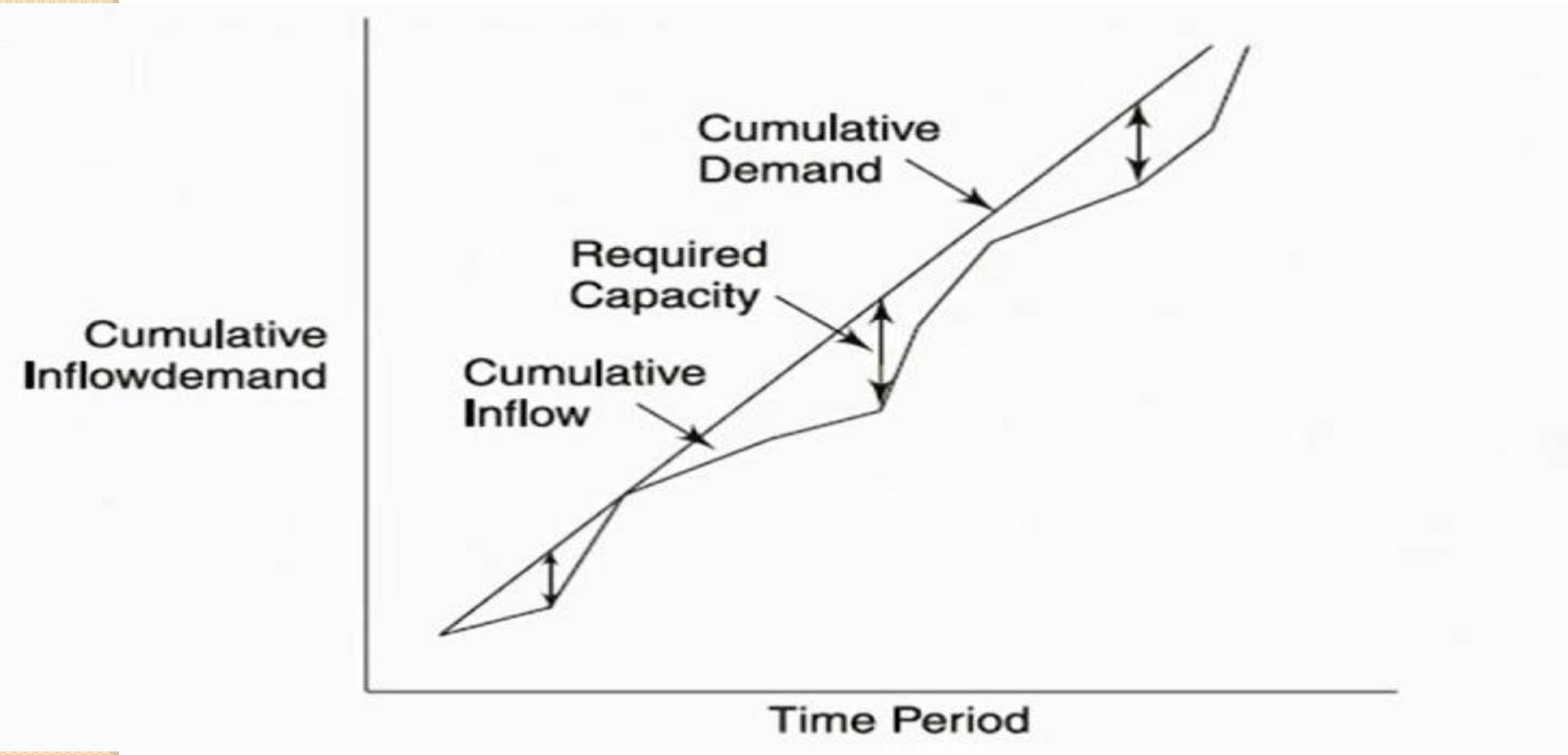
**MASS CURVE:**

Mass curve is a graphical representation of cumulative volume of water in the reservoir versus cumulative time. It will be a continuously raising curve as shown in figure.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**



# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**FIXING CAPACITY OF A RESERVOIR:**

**Mass Curve or Graphical Method:**

- Prepare the mass inflow curve for the flow hydrograph of the site for a number of consecutive years including the most critical years i.e., when the discharge is low. Figure shows the mass inflow curve.
- Prepare the mass demand curve corresponding to the given rate of demand. If the rate of demand is constant, the mass demand curve is a straight line as shown in figure. The scale selected for plotting of the mass inflow and mass demand curve should be the same.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

## RESERVOIRS:

### FIXING CAPACITY OF A RESERVOIR:

### Mass Curve or Graphical Method:

- Draw the lines AB, FG etc. such that they are parallel to the mass demand curve and they are tangential to the peak points or crest at A, F etc. of the mass inflow curve points A, F etc. indicate the beginning of dry periods marked by the depressions.
- Determine the vertical intercepts CD, HJ etc. between the tangential lines and the mass inflow curve. These intercepts indicate the volumes by which the inflow volumes fall short of demand, which can be explained as follows:

Module – 5: Canals and Reservoirs

# RESERVOIRS:

## FIXING CAPACITY OF A RESERVOIR:

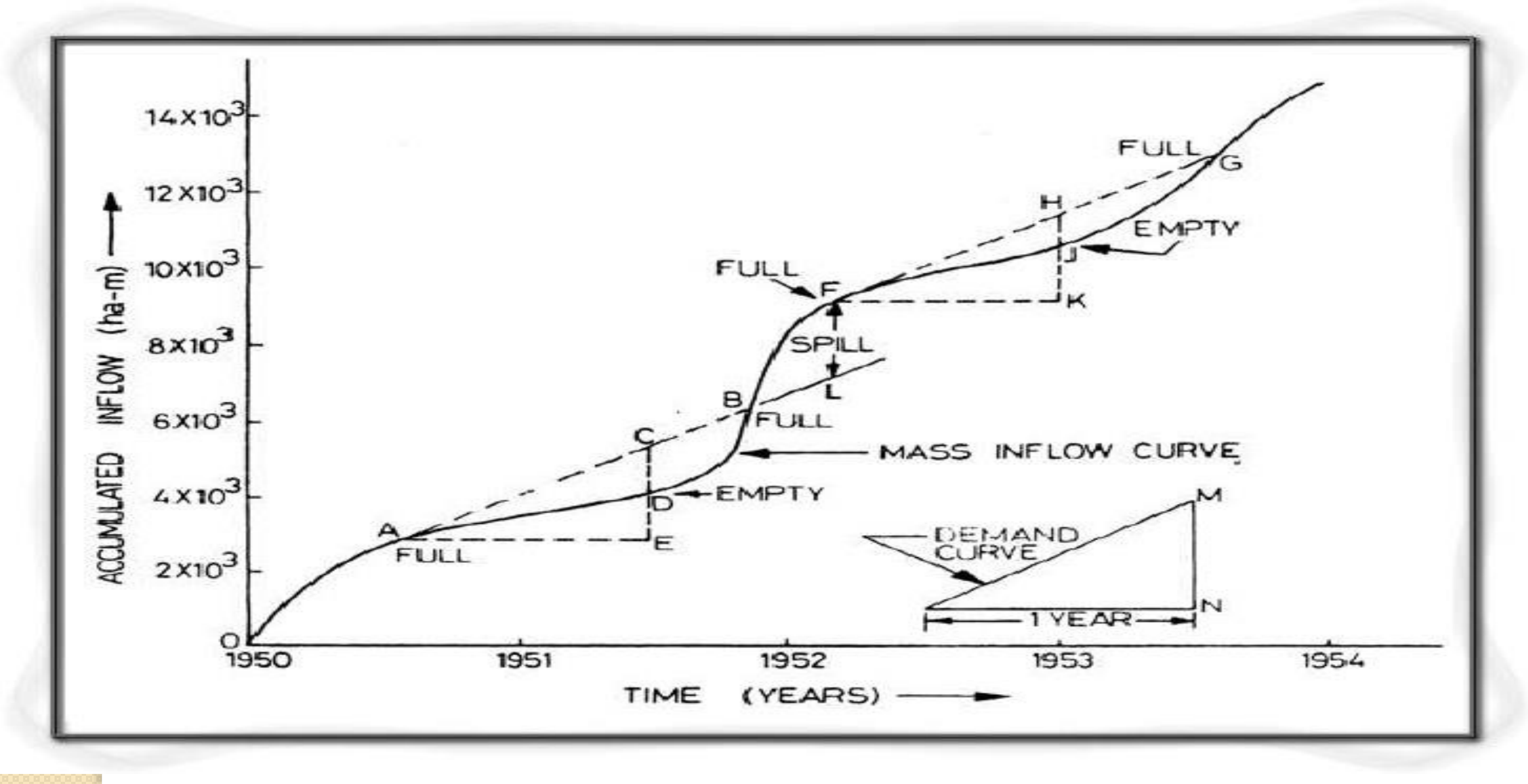
### Mass Curve or Graphical Method:

- Assuming that the reservoirs is full at point A, the inflow volume during the period AE is equal to ordinate DE and the demand is equal to ordinate CE. Thus the storage required is equal to the volume intercepted by the intercept CD.
- Determine the largest of the vertical intercept determined in step 4. The largest vertical intercept represents the storage capacity required.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**



# RESERVOIRS:

## FIXING CAPACITY OF A RESERVOIR:

### Determination of Yield of a Reservoir:

- Prepare the mass inflow curve from the flow hydrograph of the river and shown in figure.
- Draw tangents AB, FG etc. at the crest A, F etc. of the mass inflow curve in such a way that the maximum slope (intercept) of these tangents from the mass inflow curve is equal to the capacity of the reservoir.
- Measure slopes of all tangents drawn in the previous step and determine the slope of the flattest tangent.

# Module – 5: Canals and Reservoirs

## RESERVOIRS:

### FIXING CAPACITY OF A RESERVOIR:

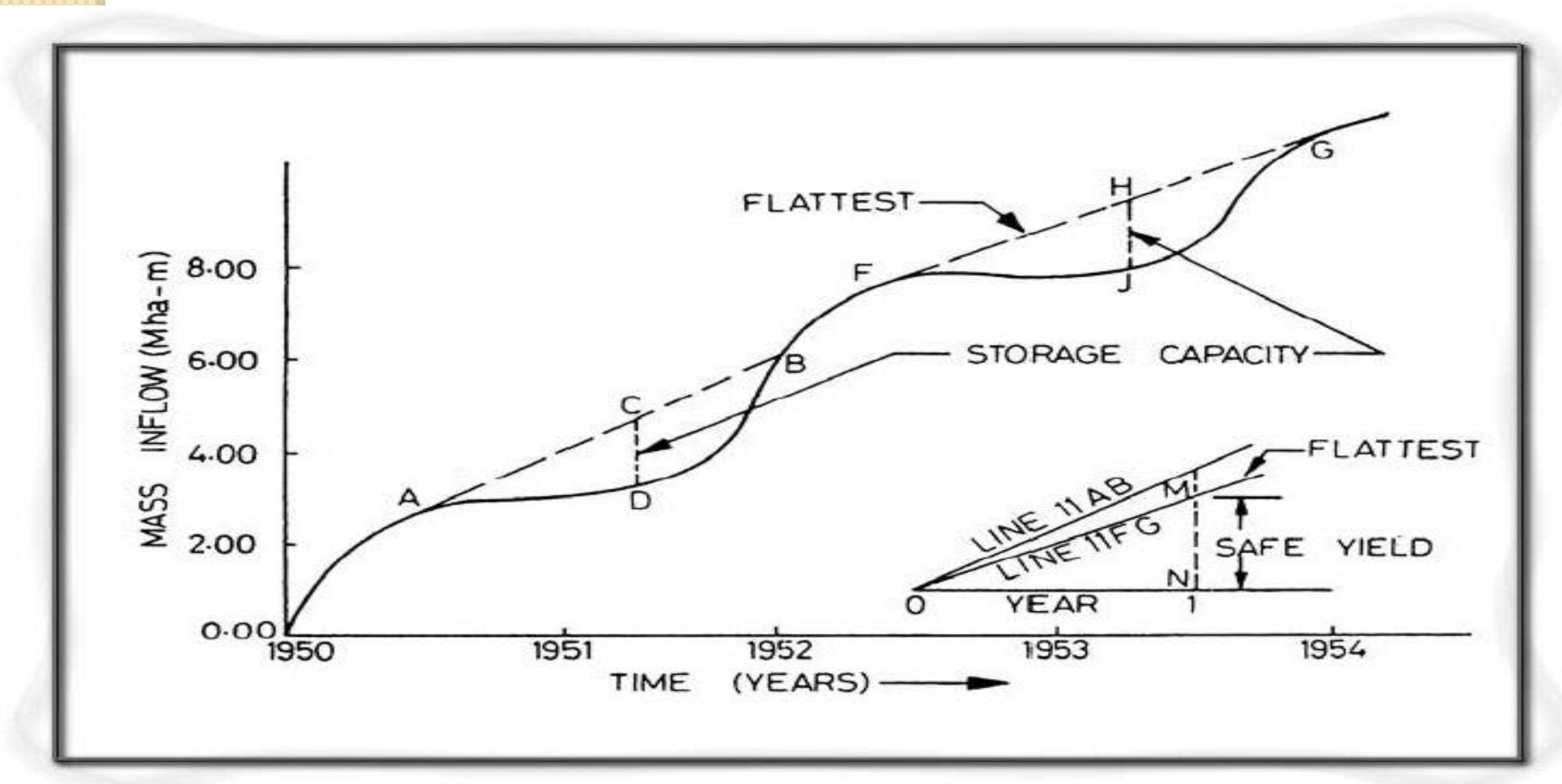
### Determination of Yield of a Reservoir:

- Draw the mass demand curve from the slope of the flattest tangent as shown in figure. The yield is equal to the slope of this line.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**



Module – 5: Canals and Reservoirs

# RESERVOIRS:

## FIXING CAPACITY OF A RESERVOIR:

### Analytical Method for Determination of Storage Capacity:

- The stream flow data at the reservoir site is collected during dry period (month wise). In case of very large reservoir annual inflow rates may be used.
- The discharge to be released on to the downstream side in order to meet the water requirements is estimated.
- The direct precipitation falling on the reservoir is calculated month wise.

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**FIXING CAPACITY OF A RESERVOIR:**

**Analytical Method for Determination of Storage Capacity:**

- The evaporation losses from the reservoir is estimated by a suitable method.
- The monthly demands are estimated.
- The adjustable inflow during different months are calculated as follows:

Adjustable inflow = {Stream flow + Precipitation – Evaporation – Downstream Discharge}

# Hydrology and Irrigation Engineering (18CV63)

## Module – 5: Canals and Reservoirs

**RESERVOIRS:**

**FIXING CAPACITY OF A RESERVOIR:**

**Analytical Method for Determination of Storage Capacity:**

- The monthly storage capacity is computed:

  Storage required = {Adjustable Inflow – Demand}

- The storage capacity of the reservoir would be the sum of all the storages determined in the previous step.