# Introduction

DEFINITION OF IRRIGATION - It may be defined as the science of artificial application of water to soil for raising crops.

Irrigation Engineering- It is the science dealing with planning, designing, construction, operation and maintenance of various irrigation works.

(i)Construction of dams and reservoirs.

(ii)Construction of canal system.

(iii)Construction of headworks.

(iv) Study and design of works in connection with river control.

(v)Drainage of waterlogged area.

(vi)Generation of hydroelectric power, etc.

## *NECESSITY OF IRRIGATION :*

The natural supply of water to the agricultural land is through rain. If the rainfall is sufficient to meet the total water requirements of the crop and it occurs at the time when the crops require it, then there is no need of irrigation.

But, India is a tropical country with a vast diversity of climate, topography and vegetation. In India, rainfall varies to a large extent from place to place. It also varies in amount of rainfall at different places.

Even at a particular place, the rainfall is highly irratic and irregular, as it occurs only during a few particular months of the year.

To get the maximum yield of crop, it becomes necessary to supply the optimum quantity of water at the right times as per the requirement of the crop. This is possible only through a systematic irrigation system.

## *Factors Creating Necessity of Irrigation*

(i) Inadequate rainfall

(ii) Non-uniform rainfall

(iii) Growing multiple crops during a year

(iv) Growing perennial crops

(v) Growing superior crops

(vi) Increasing the yield of crops

(vii) Insurance against drought

(viii) Economical use of water.

Inadequate rainfall: When the rainfall at the place is insufficient to meet the water requirements of the crops, artificial supply of water is necessary. This is essential for arid and semi-arid regions. In such cases, water is stored in dams where it is available in abundance and supplied to the arid region.

Non-uniform rainfall: The rainfall in a particular area may not be uniform over the entire crop period. During the early periods of the crop, rains may be there or may be in more than the requirement, but no rain water is available at the end of crop period or there is insufficient rain.

Growing multiple crops during a year: The rainfall in a region may be sufficient to grow only one type of crops during the rainy season (i.e. kharif season), for which there may not be required any irrigation. However, in the same region if more number of crops are to be grown during the same year, irrigation becomes necessary.

Growing perennial crops: Sugarcane is an important perennial crop which remains in the field practically during the whole year. Since, the rainfall is irregular therefore, irrigation is invariably required for sugarcane.

Growing superior crops and cash crops: For growing superior crops and cash crops cotton, fruits, oil seeds, vegetables, etc. large quantity of water is required uniformly and throughout the crop grooming, therefore irrigation becomes necessary

Increasing the yield of crops: The yield of crops per hectare is substantially increased by proper irrigation as the supply of water is properly controlled.

Insurance against drought: The crops in a region may not require irrigation during a normal rainfall year, but in the case of drought, it becomes necessary. Irrigation becomes necessary to provide insurance of crops against drought and famine.

## *SCOPE OF IRRIGATION ENGINEERING*

The scope of irrigation can be divided into the following three groups:

1. Engineering aspect.

2. Agricultural aspect.

3. Management aspect.

**Engineering aspect:** The engineering aspect of any irrigation project involves the development of a water source for irrigation and the arrangement for the conveyance of water right from the source up to the agricultural fields.

(a) Storage, diversion or lifting of water:

(b) Conveyance of water to the agricultural fields

(c) Application of water to agricultural fields:

(d) Drainage and relieving waterlogging:

(e) Development of hydropower:

**Agricultural aspect:** The agricultural aspect of an irrigation project includes the timely and systematised application of irrigation water to the agricultural fields. It deals with the following points:

(i) Proper levelling and shaping of the agricultural fields.

(ii) Soil investigation.

(iii) Provision of field channels.

(iv) Uniform and periodic distribution of water.

(v) Choosing proper crop pattern.

**Management aspect:** The management aspect of an irrigation project involves successful implementation and efficient management of both the engineering as well as the agricultural aspects of the project.

The following points must be considered in this aspect

(i) The farmers should be trained and educated.

(ii) The cultivation should be carried out in a scientific manner.

(iii) The distribution of water to the farmers should be managed properly by using some kind of rotation system such as wara bandi.

## *BENEFITS OF IRRIGATION*

**(i) Increase in crop yield:** With the timely and systematic supply of water to the crop, the yield of crop is increased. With the increased crop yield, self sufficiency in the production of food grains can be achieved easily.

(ii) Cultivation of cash crops: Irrigation facilities encourage the cultivation of cash crops (superior crops) such as wheat, sugarcane, rice, cotton, oil seeds, etc.

(iii) Increase in ground water storage: The ground water storage in the areas where irrigation facilities are available is increased and the ground water table rises. This is due to the seepage of water from the canals and agricultural fields.

(iv) Domestic and industrial water supply: The irrigation canals can also be used for domestic and industrial water supply for the nearby areas where no source of water supply exists. The canals also provide facilities for bathing, cattle watering, boating, swimming and other recreations.

(v) Elimination of mixed cropping: In case the irrigation facilities are not available in an area, the farmers generally adopt mixed farming (mixed cropping) whereby they grow two or more crops together in the same field.

But, mixed cropping has a number of disadvantages, especially due to the fact that each crop has different requirements for field preparation, manuring, watering, etc. However, with the irrigation facilities, mixed cropping can be eliminated.

(vi) Protection from famine: The provision of sufficient irrigation facilities in any region protects against failure of crops or famine from droughts. However, in the regions where no irrigation facilities are available and the farmers have to depend only on rains for growing crops, the failure of rains may result in famine.

(vii) Increase in the wealth of the country: Revenue is collected from the farmers utilising irrigation water. There is substantial increase in revenue to the state. The revenue collected may be used for the development of new irrigation schemes and systems.

(viii) Inland Navigation: The network of irrigation canals can be used for inland navigation. Hence, agricultural products can be transported to the mandis.

(ix) Communication facilities: Generally, all the irrigation canals are provided with inspection roads on one of the banks of the canal. These roads provide good communication for surrounding villages.

(x) Canal plantations: Different types of trees are planted along the canal banks. These trees provide timber and also check soil erosion.

(xi) Increase in prosperity of people: In the regions where irrigation facilities are available, the value of land is increased and hence the general prosperity of the farmers is increased.

(xii) Generation of hydroelectric power: Major river valley projects are generally planned to provide hydroelectric power together with irrigation. Generation of hydroelectric power is also possible at falls on the irrigation canals..

(xiii) Overall development of the country: The provision of irrigation facilities results in the overall development of the country. The supply of irrigation water leads to improved agricultural pattern, increased crop yield and increased employment.

(xiv) Aid in civilization: Irrigation schemes are helpful in bringing civilization to the area through prosperity.

## *ILL-EFFECTS OF IRRIGATION*

(i)Waterlogging: Cultivators generally use more water than actually required by the crops.

The excess water percolates into the ground thereby rising the water table.

Waterlogging occurs when the water table reaches near the root zone of the crops.

The soil pores become fully saturated and the normal circulation of air in the root zones of the crops is stopped thereby decreasing the growth of crops and hence crop yield.

When the water table reaches the ground surface, the land becomes saline.

The land ultimately becomes unfit for cultivation.

(ii) Mosquitoes nuisance: Due to excess application of water and due to leakage from canals and pipelines, the pits and depressions get filled up with water.

These stagnant pools of water facilitate breeding of mosquitoes and the region becomes malaria prone.

(iii) Damp climate: The areas which are already damp and cold becomes damper and colder due to irrigation.

(iv) Pollution of ground water :Majority of the water applied on the irrigation fields is lost to the atmosphere by evapotranspiration and only a part of it appears as irrigation return flow.

The return flow includes nitrates and phosphates used as fertilizers. Moreover, several harmful toxic chemicals used as pesticides are contained by dissolution in the return flow This makes the water in a river or water reservoir, polluted.

## *MAJOR, MEDIUM AND MINOR IRRIGATION PROJECTS*

The methods used for irrigation in India can mainly be divided into the following three categories:

1.Major irrigation projects

2. Medium irrigation projects

3. Minor irrigation projects.

1. Major Irrigation Projects: The irrigation projects which cover an area of more than 10,000 ha (100 km²) are classified as major projects. These projects are handled by irrigation and water resource department.

Major irrigation projects in India are as follows:

(i)Bhakra Nangal project

(ii)Indira Gandhi canal project

(iii) Beas project

(iv) Chambal project

(v)Hirakud project

(vi) Damodar valley project

(vii) Tungabhadra project

(viii) Kosi project

(ix) Dr Nagarjuna sagar project

## 2. Medium Irrigation Projects :

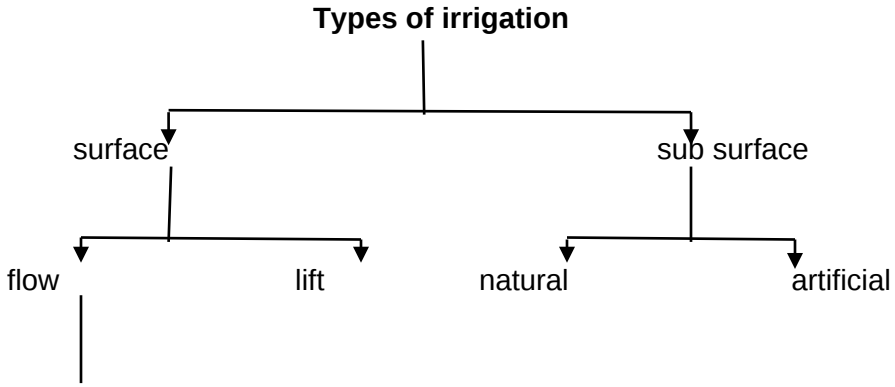
The irrigation projects which cover area between 2000 ha to 10,000 ha are classified as medium projects. Small dams and small canals network are under medium irrigation projects.

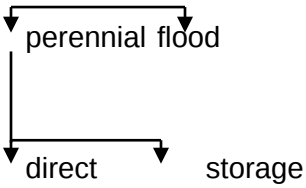
## 3. Minor Irrigation Projects:

The irrigation projects which cover area less than 2000 ha (20 km²) are classified as minor projects. Minor irrigation schemes include the construction of open wells, tube wells, small canals and tanks. Due to a large number of small irrigation schemes in India, it serves a substantial part of the total irrigation in the country. These projects are maintained by Zila Parishad, Panchayat or Corporation.

# Chapter 4

# METHOD AND TYPE OF IRRIGATION






1. **Surface irrigation** - In this surface water is use for irrigation.

Flow irrigation :- when the water is available to the higher level and it is supply at lower level under action of gravity.

Lift irrigation :-when the water is lifted from lower level to higher level for irrigation by mechanical pump.

Perennial irrigation:- A constant and continuous supply of water is available for Complete crop period this type of irrigation called P.I.

Flood irrigation :- In this type the soil is flooded with water and soil get saturated. This saturation help the crop for their, growth.

Direct irrigation:- when irrigation is done directly from a water source such as rivers.

Storage irrigation:- if water is store in reservoir or tanks and the it is use for irrigation purpose.

2. **Sub surface irrigation** :- In this type of irrigation, under ground water is used by plants for their growth by Capillary action..

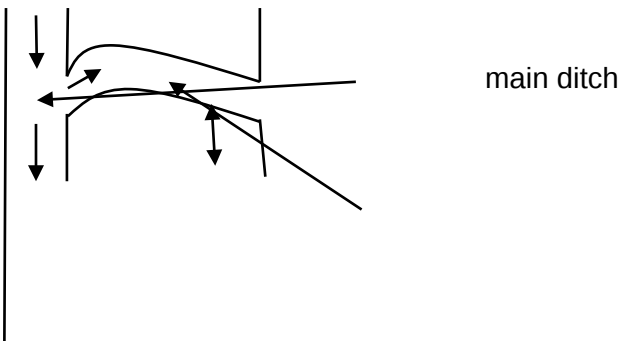
Natural sub-surface irrigation (N.S.S.T.) :- Due to Capillary water in soil voids. if irrigation is done it is known as a natural sub-surface irrigation.

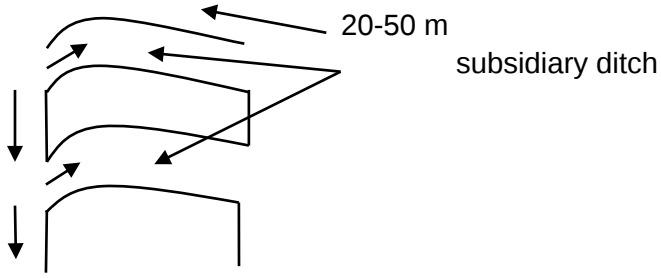
Artificial sub surface irrigation (A.S.S.I.) :-when a System of drains such as pits are used under irrigation project it is known of (A.S.S.I.).

## Methods of irrigation:-

### 1- Free Flooding method (wild Flood) :-

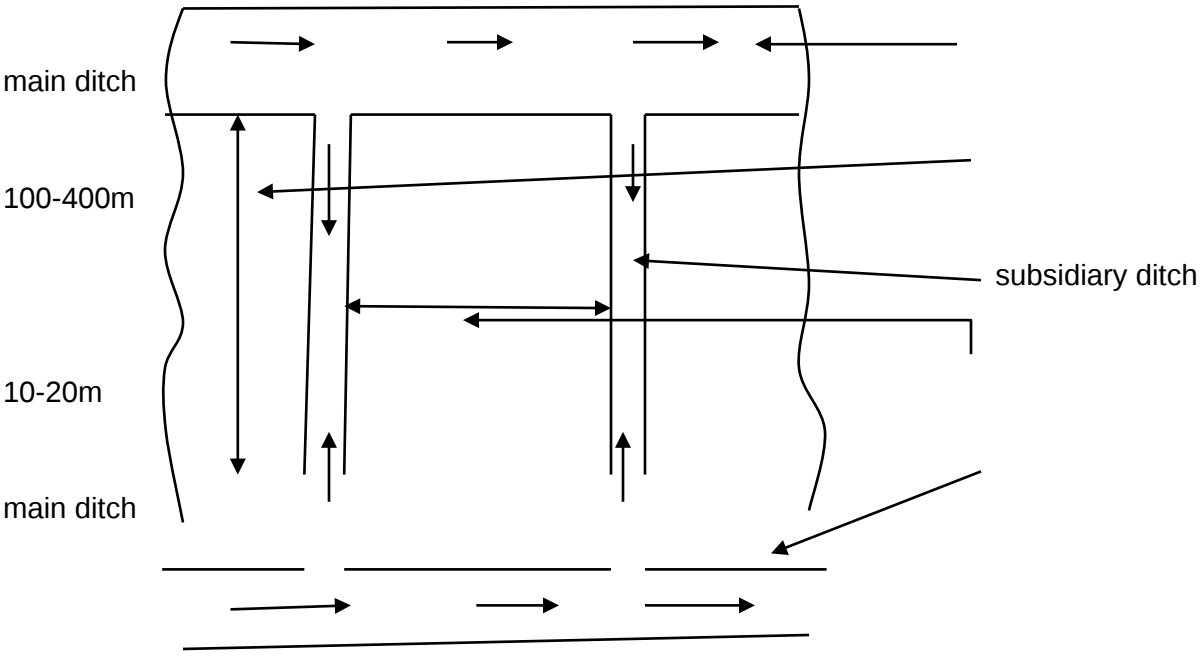
- water flows along ditches under gravitational force.
- The Spacing between subsidiary ditches vary from 20m-50m.
- In this method there is no control Over flowing water.
- It is used for rolling land (steep slope).
- efficiency at this method is low due to high evaporation and seepage loses.
- Subsidiary ditch can be on single side of a main ditch or on both side of main ditch.





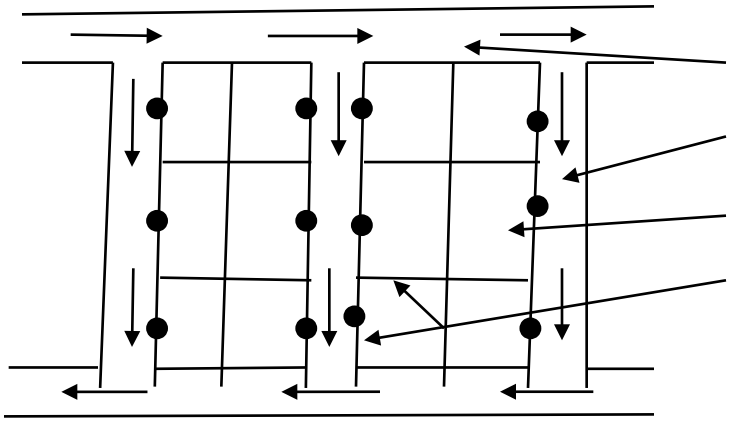

## 2- Border Flooding :-

- It is most popular method used in India.
- In this method the land is divided in no. of stripes which are known as border.
- The size of stripes depends upon soil characteristics, slope and discharge.
- The area in borders is limited 10-20 m in width and 100-400 m in length.
- This method is used four closed growing Crop such as wheat.




## 3- Check Flooding method :-

- in this method water is Controlled by formation of flood lieves.
- The area b/w flood leeves is known as check area and its value is around 0.2 ha ($104m^2$).
- method is used fan moderate, and high infiltration Capacity soil.
- each check area of plot has nearly levelled Surface.
- Generally their is one field Channel for every two rows of plot.



main ditch

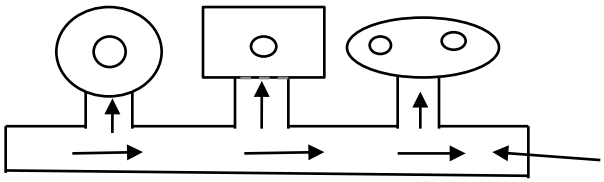
subsidiary ditch

check area /plot

leeves

## 4- Basin flooding method:-

- Main ditch is Connected to basin by narrow channel.
- The basin may be square, circular or irregular in shape.
- This method is used for orchards.
- In Some cases basins of large sizes are made to include two or more then two trees.
- Some times pipes are used instead of field Channel for filling water in under individual basin.
- Sand is not suitable for basin flooding due to high bucking nature.



main ditch

## 5- Furrow irrigation:-

- Furrow are small channels which are used to carry irrigation water.
- In this method only 1/5th to1/ 2nd surface is wetted.
- The depth of furrow may vary from 8cm to 30cm and length vary up to 400m.
- It is used for flat surface having slop less than 0.5%.
- This method has comparatively low loses.

## Types of Furrow:-

**Straight Furrow :-** These are furrow which are aligned more on less along straight Lines, parallel to each other.

Contour furrow:- These Furrows are curved in plane. These are usually adopted when the land to be irrigated has relatively steep slope.

6- Sprinkler irrigation :- In this method water is applied in the form of sprinkler/spray through network pipes and nozzles.

- In this method their is no less of cultivation area.
- It has high evaporation loss.
- This method is used for step farming or sloping ground. ex Tea, coffee crops.

## Conditions Favourable for sprinkler irrigation:-

- when the land can not be prepared for surface method.
- Topography is irregular.
- Slope are excessive.
- soil is erosive.
- when soil is excessively permeable.

## Component of sprinkler irrigation system:-

Pumping unit:-In this unit the pump lift water from a water source.

Main delivery pipe :- These are usually buried in ground. These are made of Concrete, Cement, cast iron and Plastic.

Lateral Pipe :- These pipe are, Connected to main pipe line. Sprinklers are fitted on lateral pipes with the help of riser.

Sprinklers These are two type.

1. fix head 2. rotating head

## Advantage of sprinkler irrigations:-

- Run off and seepage loses are less.
- over irrigation is completely eliminated and uniformly of application is high.
- Irrigation water requirement reduced as Compare to other method.
- No land levelling require.
- The system allows better weed (unwanted plants) Control.

## Limitations of sprinkles irrigation:-

- in high wind regions and by effect of temperature efficiency and uniformity is less.
- cost is high due to higher energy requirements.
- Not Suitable four paddy crops.
- water with impurities may damage the system.

## 7- Drip irrigation:-

- This method was First introduce in Israel. In this method water directly apply to the root zone of Plant through a special outlet device known as emitter.
- It has no seepage lose and no evaporation lose.
- This method has high efficiency but it not economical.
- Duty of this method is very high.
- emitters are used to supply water drip by drip at very slow rate.

## Component of drip irrigation:-

control head :-It Consists of overhead tank ,flow control value, filter Pumping unit etc.

Pipe network:- The pipe network Consist of main line and no. of lateral pipes.

Emitters:- These are provided on lateral Pipes with suitable spacing depending upon type of crop and type of soil.

## Advantage of drip irrigation:-

- high water application efficiency.
- levelling of the field out not necessary.
- Ability to irrigate irregular shape field.
- Allow safe use of recycled water.
- moisture within the root zone Can be maintain.
- highly uniform distribution of water.
- Low Labour cost.
- Reducing the rise of disease because foliage remain dry.
- operated at lower pressure then other type of irrigation.
- variation in supply can be regulated by value and Emitters.

## Limitation of Drop Irrigation:-

- Initial Cost of component is very high.
- Emitters are some time clogged by clay or silt.
- this method is not suitable for closely planted crop such as wheat.
- During high winds the plants may breaks due to shallow root depth.
- There is wastage of water, time if not installed properly.

# Chapter-5
# Canal

***Canal:-*** Canal is an artificial channel, generally trapezoidal in shape, constructed on the ground to Carry water to the field either from a river or from a tank or reservoir for various purpose such as irrigation, power generation.

## *Classification of irrigation Canals:-*

### Base on the type at soil.

- Alluvial

  Canal:- which are excavated on alluvial soil such as silt.

- Non-alluvial

  Canals:- which are excavated in non alluvial such as clay hard soil.

### Based the nature of source of supply:-

- Perennial Canal :- In which water is available throughout the year.
- Non-perennial canal :- in which water is available only during monsoons.

## Based on Function of the Canal:-

- Feeder Canal:- It is Constructed with an idea of feeding two or more Canals.
- Carrier Canal:- A Canal besides during irrigation carries Canal water for another canal.

## Based on discharge:-

### Main Canal:-

- it Carries water directly from river.
- This Canal Carries heavy discharge and is not used for direct irrigation.
- It is supplies water to branch Canal and major distributary.

### Branch Canal:-

- The Canal taking off from main canal.
- They are also not use in direct irrigation.
- These canal Cary a discharge Over 5 cumecs.

### Major distributary:-

- The discharge varies from 0.25 to 5 cumecs .
- These are the use pour direct irrigation.

### Minor distributary:-

- These canals take off from major distributary.
- Discharge is Less than 0.25 Cumecs.

### Water Course on field channel:-

- These are small channels which feed water to irrigation field.

## Based on financial Output:-

Productive Canal  Protective Canal

## Based on channel alignment:-

### Contour Canal:-

- A channel which is aligned Parallel to Contour of area.
- The contour canal can irrigate only one side.
- A Contour Canal has to cross drainage and hence Canal cross drainage work are to be Provided.

### watershed Canal:-

- These are also known as ridge canal.
- It is aligned along a watershed and run for most at its length along watershed.
- When the Canal runs on watershed it can irrigate both sides of banks.
- No cross drainage work is required.
- These canals are very economical.

### Side Slope canal:-

- The Canal which are aligned at right angle to the contours of area.
- It can irrigate only one side as in Case of Contour Canal.
- Such a Canal would be roughly parallel to the natural drainage so no cross drainage work is require.

## Canal alignment:-

- The location of centre line of the ground is known as of the canal alignment.
- The canal alignment should be such that it can irrigated maximum area.

## Factor affecting canal alignment:-

- An irrigation canal should be such aligned on a watershed as far to be possible because it ensures irrigation on both side of canal.
- A Canal should have minimum no. of drainage.
- As far as possible Curves should be the avoided in the alignment of Canal.
- The Canals should avoid villages ,roads , places of worship and other valuable properties.
- The alignment should pass through the balance depth of cutting.
- The alignment should not be made in a rocky strata.
- The alignment length of Canal should be minimum.
- As far as possible the Canal alignment should be in the centre of Commanded area.

## Various Part of Canal Section :-

I. Side slope:- The slope of the cut or fill expressed of the ratio of horizontal distance to vertical distance.

II. Berms :- The horizontal distance left at ground level b/w the top of the bank to the top edge of cutting.

III. Free board:- The vertical distance b/w designed full supply level and bank level.

IV. Banks :- Bank are Constructed on both side of the Canal to retain water in Canal.

V. Dowel :- It is the raised portion over bank by the side of an Inspection read.

VI. Inspection road:- It is usually Provided on both side of the on Canal bank for the Purpose of inspection, repair, maintenance of road.

VII. Borrow pit:- The Small pits which are dug to obtain the extra earth for making banks if the soil obtained from cutting is not sufficient.

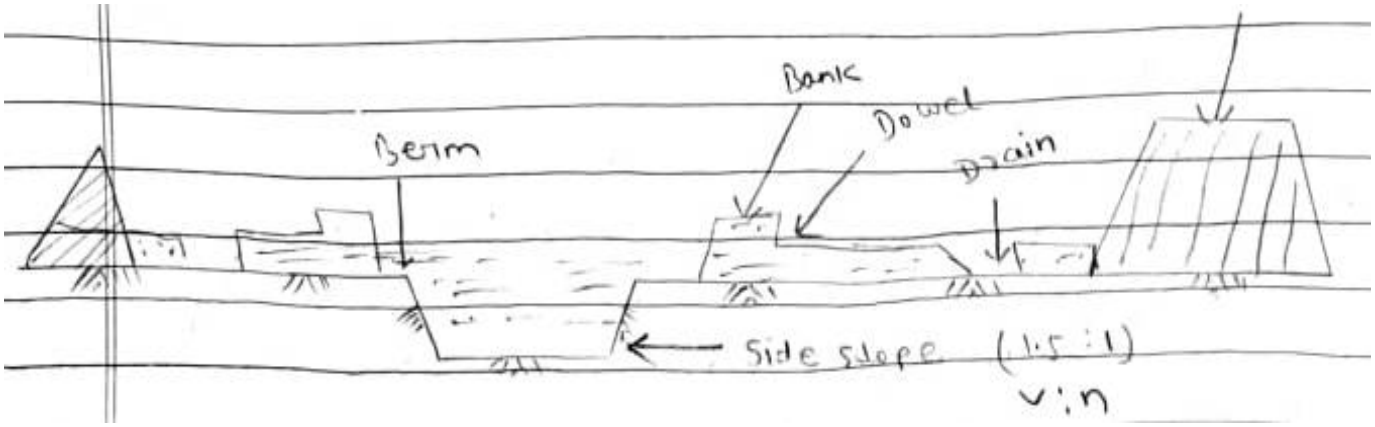
VIII. Spoil Bank:- When the quantity of excavated earth is much in excess of the quantity require for filling it has to be deposited in form of spoil bank.

IX. Land width :-

Width land required for Construction of canal Cross-section is called land width.

X. Counter

Berm :- Even after providing the usual embankment section of a bank the Saturation gradient may Cut the downs stream side of bank. In such case the saturation line is kept Covered by at least 0.6m with the help at another berm on the backside of bank. Such beam is known a as Counter Berm.




**Canal lining :-** Laying of impervious layer which protects the bed and sides of the Canal is called Canal lining.

- The impervious layer itself is called Lining.
- Canal lining also known as rigid boundary.

## Necessity of Lining :-

- To minimize seepage losses in Canal.
- To prevent erosion of bed and side of canal.
- To eliminate silting in canal.
- To reduce maintenance of Canal.
- To retard the growth of weeds.
- To increase discharge in canal by increasing velocity.

## Advantage of lining:-

- it ensures economical water distribution.
- It reduce seepage loss.
- higher velocity of flow result in reduction in evaporation loss.
- higher velocity prevents silting of canal.
- It prevents canal erosion and Canal breaches.
- maintenance cost of lined canal is less as Compare to unlined canal.
- The lining provides smooth surface and higher velocity of flow.

## Disadvantage of Lining:-

- It require a heavy a initial investment.
- It is very difficult to repair the damaged lining.
- Cannot divert Canal or outlets.

## Type of Canal lining:-

I. concrete lining.
II. Brick Lining .
III. cement mortar lining .
IV. stone masonry lining.
V. Shotcrete lining .
VI. Sodium Carbonate lining.
VII. precast Concrete block lining
VIII. asphaltic lining.

## Concrete lining:-

- The lining which is done by Concrete Lining is Called Concrete lining.

- The Concrete may be of Cement Concrete or lime Concrete.
- It helps in reducing absorption losses by 90-95%.
- It is suitable four small and big canals.
- The Canal section remain stable in case of high velocity.
- Concrete lining are frequently higher in initial cost but due to minimum maintenance usually makes them most economical.
- Reinforcement should be provided in concrete lining when the soil is of bad quality.
- The slump values Should be checked So that neither too high.

## A satisfactory Concrete lining requires the following:-

I. well design mix.
II. well graded aggregate.

## Construction of Concrete lining:-

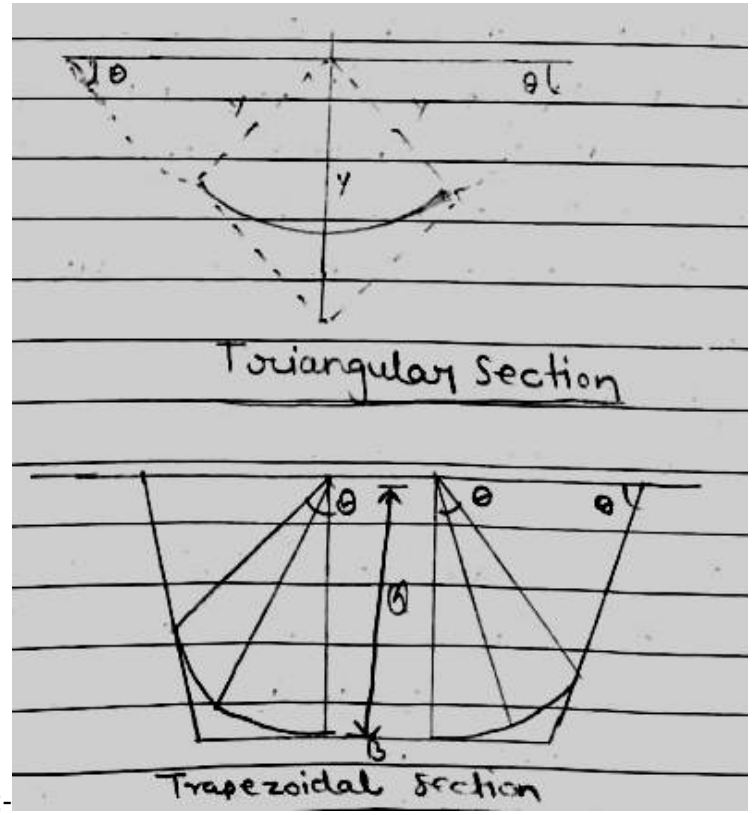
- Compact the subgrade with sheep foot roller.
- To make Paper the lining water tight spread oil paper or crude oil.
- Now place the Concrete either by hand or by machinery.
- After this Curing must be carried.

## **Brick lining:-**

- The lining done by brick is known as brick lining.
- This type of lining is very useful in India.
- while construction brick lining following Points should be kept in mind.
- To Saturate the subgrade sail thoroughly.
- to allow the plaster to set properly for two days.

- to reject the use of un burnt bricks.
- to soak the bricks in water thoroughly in water.

Gross section of Lined Canals:-




**Canal Breaches:-** The gap created in the canal banks due to breaking up of the banks are Known as Canal breaches.

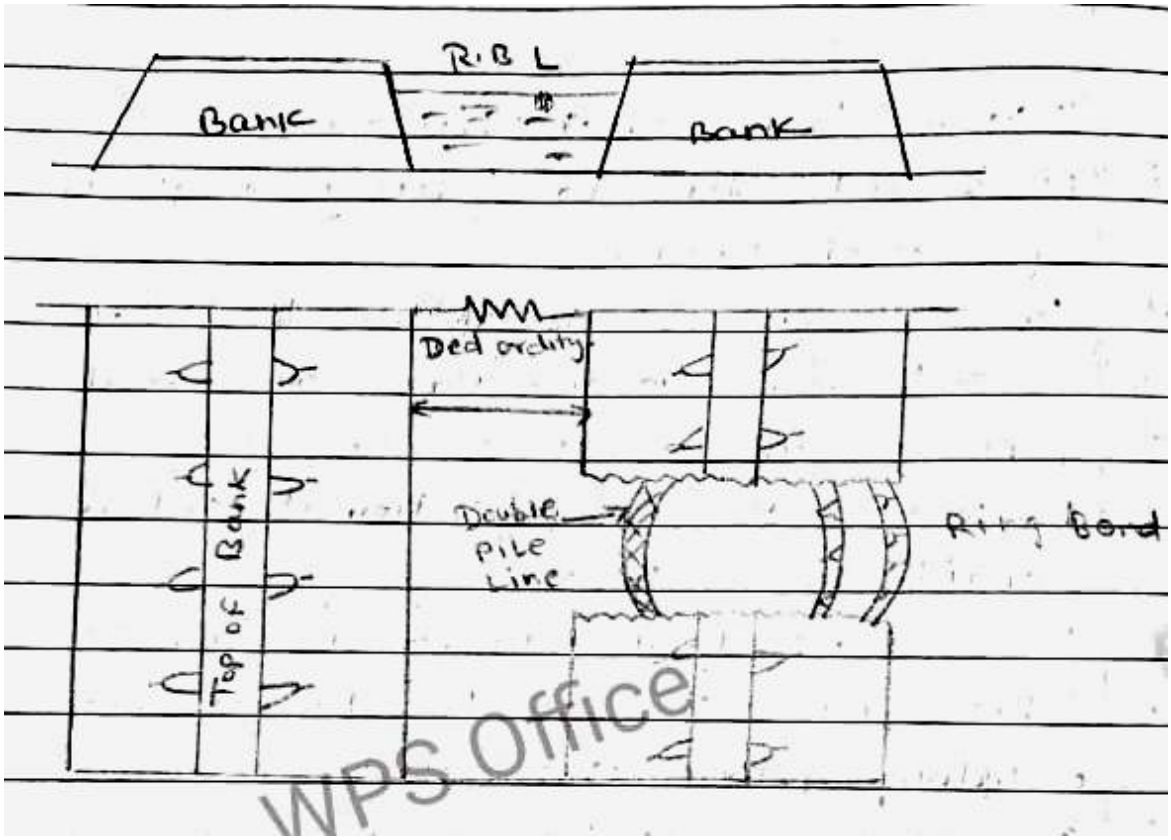
## Reason four canal breaches :-

- A breach due to faulty design or Construction of Canal bank.
- Breach due to overflow of canal.
- Breach due to leakage of canal water.
- piping due to excess supply.
- Breach due to intentional cut by the farmer.

Detail from book:-

# Procedure for closing Breach :-

- This first step is to slow or to reduce the outflow from the Canal.
- It can be done by opening some other Connected channel.
- next Step is to cut the side of gap in form of steps.
- It gives proper bond to newly deposited material with old bank.
- Drive double pile line in the opening of breach.
- The space b/w the pile line is filled with Planks bushes. It retard the flow of water.
- when the outflow is reduced sufficient earth is deposited on both side of gap.
- It is then dumped instantly from both Side to form ring bond. on the outer Side of breach.
- Then the opening is properly filled with Suitable earth in layer.



# Maintenance at irrigation canal:-

- Internal silting method
- External silting method
- Formation of berms and counter berms
- Aquatic weed control
- Silt removal ( silt ejectors and silt escapes)
- Maintenance of service roads