Irrigation techniques and quality of irrigation water :

* Defination of Irrigation :

Irrigation is defined as the science of artificial application of water to the land in accordance with the crop requirement through out the crop period for full fledged nourishment of the crops.

Necessity of Irrigation in India :

India is a tropical country with a vast diversity of climate, topography and vegetation. Rainfall in India varies considerably in its place of occurance as well as in its amount. Even at a particular place the rainfall is highly erratic and irregular as it occurs only during a few particular months of the year. Crops cannot thrive over the entire land, without providing artificial irrigation of fields.

More than 70% of our population directly depends on agriculture and the remaining depend indirectly on agriculture. Out of a total geographical area of about 328 million hectares about one million hectare about 184 million hectares is the cultivable area.

It is necessary to provied ~~[illegible]~~ adicuaty and its adequate irrigation facilities to ensure full growth of on the cultivable area.

In order the achive the Government is trying hard and spending enormously to provied irrigation facility for the entire cultivable land.

Advantages of Irrigation:

Every irrigation project is design keeping in view of its economics that is the expenditure likely to be encoure an benifits are to occour. Some of advantages of irrigation are sumbed below.

→ Increase in full production:

~~Increase~~ Irrigation help increasing crops its and hence to attened self sufficiency of food.

→ Optimum benifits:

By optimum ~~irrigation~~ cultivation we maximum all its requirement water.

→ Ellimination of mixed croping:

In the eara is not assure general is mix croping is addpoted. By mixed croping we mean showing together of two or more crops in the same ~~[illegible]~~ field, But if

Irrigation is assure mixed cropping can be eliminated

→ General prospering :

Revenue returns with well developed irrigation are sometime quite high and hence in all round development of the country and prosperity of the Indian nation and community.

→ Generation of hydro electric of power :

Cheaper power generation can be offered from water development project primarily design for irrigation along.

→ Domestic water supply :

Development of irrigation facility in an area helps in providing the water supply is near by villages or town where other source of water are not available or are scanty available.

Disadvantages of irrigation :

Irrigation may result is a compare marshy land and growing of mosquito causing outfit like Malaria & dengu.

Over irrigation of water logging and

may reduces ~~crop~~ crop ~~yield~~ yields.

Procuring and supply irrigation of water is complex and expensive ~~for~~ in itself.

Techniques of water distribution in the farms:

There ~~is~~ are ~~a~~ various way in the irrigation water to the field. The main classification is are follows.

i) ~~flo~~ free flooding
ii) board flooding
iii) check "
iv) Basin "
v) furrow irrigation method
vi) sprinkler " "
v) Drip " "

Free flooding:

→ In this method this are expended in the ~~low~~ field they may be either on the ~~coast~~ coast of

→ Water for these flows across the field.

→ After the water ives the ditch no

attemp is made to control the flow by which of lines etc.

→ Since the moment the water is used to it modified it is called as wild.

The initial coast of the land is preparation of and water application is low. This wild flooding its most suitable for closer growing where the land is spear.

→ Countin dies on suffiene ds are generan space about 20-50m apart depending upon the slow feature of soil crops to be growth etc.

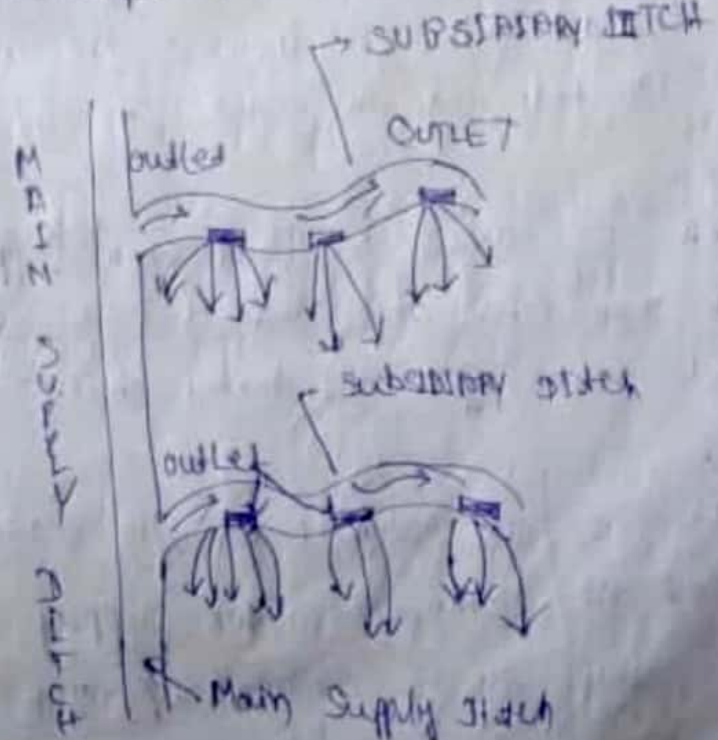

Fig: Free flooding

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Boarder flooding :

- In this method land is divided into a series of long uniformly graded narrow strip separated by low levees.

- Here, levees guide the flow of water down the field.

- Usally length of ~~the~~ strips in the range 100-400 m. where width of strips is in the range 10-20 m.

- This method is suitable when the area is level in direction perpendicular to the flow in ~~order~~ order to prevent the water from consentrating on either side of the boarder.

- Water is allowed to flow from supplied ditch into each strees, and during it's travel water gets infiltrated ~~in~~ into the soil.

- As soon as the water reach the lower end of the stream water supply to that strip ~~the~~ is turned up. This is the most popular method of floding.

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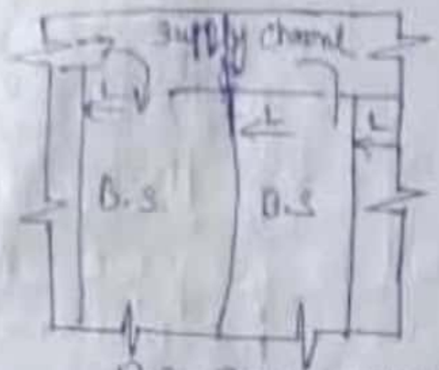
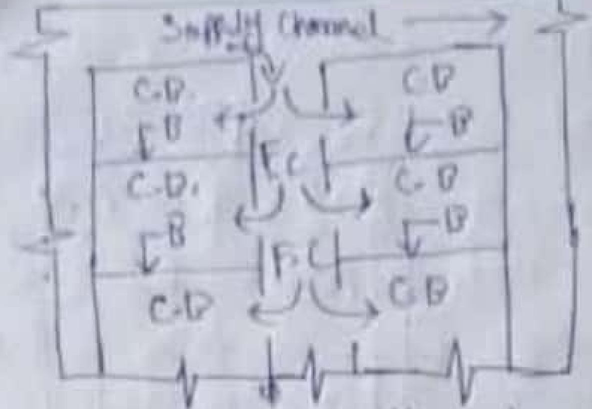


B.S = Border Strips
L = Levees

Check flooding!

- In this method Agricultural area is divided into small plots that is known as checks by surrounding the area with low & flat levees. These levees act as check bunds.
- Check bunds are generally constructed along the contour.
- Water is supplied to the check basin through the field channel which are connected with supply channel.
- This method is suitable for both more permeable and less permeable soil.
- Close growing crops such as jowar are most preferred.



F.C = Field Channel
B = Bunds
C.B = Check Basin

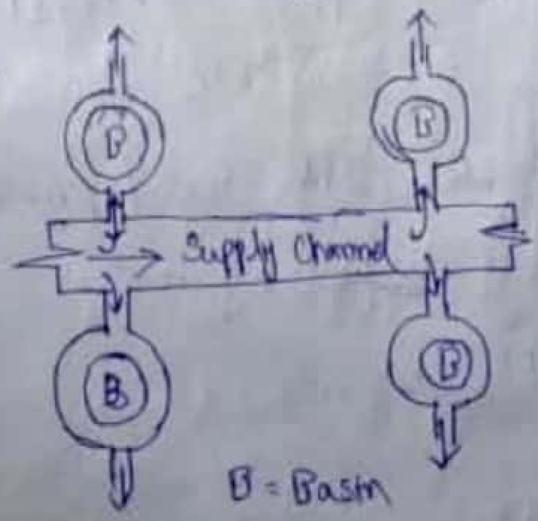
Basin flooding :

- This method is mainly employed for watering orchards.

- In this method, one or more trees are generally enclosed by a circular channel through which water flows.

- This circular channel acts as basin.

- This method is suitable for crops that are not affected on stagnating water present over long periods of time.



B = Basin

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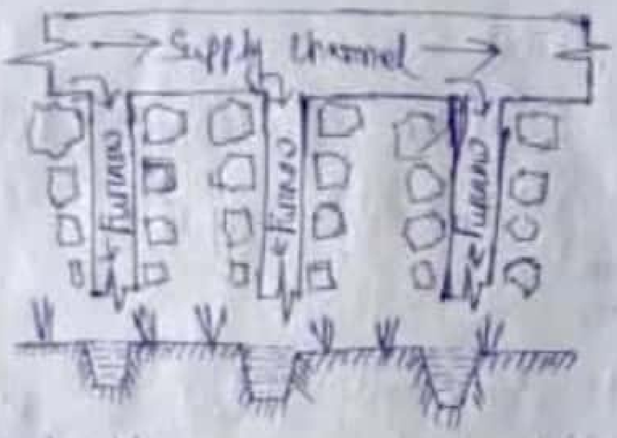
Furrow Method :

- In this method water is supplied to the land by digging narrow, channel at regular interval.
- These narrow Channel are called furrow.
- Depth of furrow varies from 8-30 Cm while length of furrow is 400m.
- This method is suitable for crops, like sugarcane, tobacco, groundnut, Potato etc.



Sprinkler irrigation :

- In this method irrigation water is applyed to the land in from of a Spred.
- water is a Spred by employing by Network of Main Pipe, Submain Pipe & lateral Pipe.

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Advantage of sprinkler irrigation:

- No land levelling is required ~~...~~
- Labour cost is reduce as no land preparation is required.
- 80 % of water application efficiency achieve
- Water is uniformly applied.
- Erosion of soil
- Can be efficiently used for whole range of topography soil and crop.

Disadvantages of sprinkler irrigation:

- System is a bit costly to install operate and maintain.
- Continuous supply is required
- Cover rain on irrigate.
- Water is high constitution in under high temperature become loses

Drip irrigation / Trickle irrigation :

- It is the latest method of irrigation.
- In this method water & fertilizer are slowly and directly applied to the root zone of the plant in order to minimize the evaporation and seepage losses.
- This method is suitable for tomato, grapes, corn, cauliflower, cabbage etc.

Advantages of Drip irrigation :

- Water requirement is minimum.
- Evaporation losses are close to negligible.
- Higher rate of vegetable to growth although in this method.
- Soil surface is wet water.
- No land levelling is required.
- No soil erosion take place.

Disadvantage:

- High skill is required in the design installation operation and maintenance.
- Needs regular flushing and supervision.
- Plastic pipe may get affected and reacted.

Water requirements of Crops :

- The term water requirement of ~~crop~~ means the total quantity of required ~~of~~ by crop from the time it is ~~shown~~ sown to the time it is harvested.

- Water requirement varies with the time as well as place.

Cropping ~~Seas~~ Seanstorry

There are 2 season crop in Indian.

1) Rabi (From October to March) Winter crops

(i) Rabi crops need relatively ~~the~~ cool climate during the period of growth but 1 climate during the jermision of sin of Maturation.

Ex: ~~Wheat~~, Mustard, Barli, Grown, Pea

ii) Kharif (From April to September) Monsoon crop

Crop as sown at the beginning of South west Monsoon & ~~at~~ harvested at weight of Monsoon.

(ii) Zaid Crops :

- These are shorter crops decide rabi & Kharif which are being ~~grown~~ through out ~~the~~ the year with the help of artifial

Irrigation.

* - Zaid crop are devided are Zaid Kharif crop &
  Zaid Rabi crop

Duty:

- Duty is defien as an area of land irrigated by a unit discharge of water flowing continously for the duration of the base period of the crop

- It is Dinoted by 'D'.

- Duty is mainly measure in hecton per m^3/sec.

Factor affecting duty of water:

i) Type of crop
ii) Climatic condition
iii) Method of irrigation
iv) Type of soil
v) Time of irrigation & ~~Lienstdgy~~ Ficulotic of cultivation

Delta:

- Delta is a total depth of water in centimeter required by crop to come to maturity.

- It is dinoted by symbol Δ

Crop Period :

Crop Period is the total time period from the instant of showing crop to the instant of harvesting the crop.

Base Period :

Base period is the total time period from the 1st watering done the Preparation of land to the last watering done before it's harvesting crop. It is Dinoted as B.

Relation between Duty, Delta and Base Period :

- Let, there be a crop of base period of B days. to this crop 1 cumic of water is applied B days.

∴ Volume of water is $V = 1 \times (B \times 24) \times 60 \times 60$sec

$= 86400 \times B$ Cubic meter

Let, V cubic meter of water Mature D hector of land.

D hector of land is $D \times 10^4$

$D \times 10^4$ sq.m.

Delta $\Delta = \frac{Volume}{area}$

$$\frac{86400 \times B \text{ Cubic metre}}{D \times 10^4 \text{ Sq metre}} = \frac{8.64 \times B}{D} \text{ metre}$$

$$\boxed{\Delta = \frac{8.64 \times B}{D}}$$

Where, D => Duty of water on the field (in hectare per cumec)

Δ => Total Depth of water supply to a crop growing on the field during the total Base Period (in m)

B = Base Period of Crop (in days)

Command area :

It is that area which can be irrigated by Canal system.

Gross Command area :

It is the total area which can be irrigated by a Canal. So that unlimited quantity of water is available.

Culturable Command area :

It is that version of that area that is culturable or cultivable.

CCA = GCA − unculturable area

~~CCA~~

Culturable cultivated area

unculturable cultivated area

Intensity of Irrigation :

- Intensity of Irrigation is the Percentage of CCA Propose to be irrigated annually.
- By adding intensities of Irrigation for all the crop season we obtained the yearly intensity of irrigation.

* Paleo Irrigation.

Watering done prayer to the sowing ~~seed~~ of the crops is called Paleo irrigation and it is required for the initial growth of crops.

Kor watering :

- 1st watering done after the plants have grown ~~gone~~ a few cm high is known as kor watering.

Capacity factor :

Capacity factor = ~~*~~ avarage supplyed ~~water~~ dicharge capacity of a Canon.
―――――――――――――
Maximum ~~discharge~~ supplyed ~~sup~~ dischange capacity of a Canon

Time factor :

Time factor = No of days canal has actualy run during a watering run by no of days of watering period .

Crop ratio :

Crop ratio is the ratio of the land irrigated during the 2 main crop Season that is Rabi and Kharif

IRRIGATION Effeceny :

Irrigation effeceny = $\dfrac{\text{water avaible for used}}{\text{Water applyed during irrigation}}$

Water converge efficieny (η_c) = $\dfrac{\text{Quantity of water deliver into the field } (W_{f})}{\text{Quantity of water diverted into the canal system from the irrigation } (W_{r})}$ it include losses.

Which occurce in coverious from

to the field

Water application efficiency (η_a) = quantity of water stored in the root zone of the plant (W_s)

---

quantity of water diverted to the field.

Water use efficiency (η_e) = quantity of water used beneficially (W_u)

---

quantity of water delivered to the field (W_f)

Water distribution efficiency $(\eta_d) = \left(1 - \frac{y}{d}\right) 100$

where,

y = Average numerical deviation in depth of water stored

d = Average depth of water stored ~~in the~~ in the root zone during irrigation.

Water storage efficiency (η_s) = quantity of water stored in the root zone during

Irrigation (W_R)

Quantity of water needed ~~the~~ to bringe the mostine content of the soil to the field capacity.

Consumptive irrigation requirement:

It is the amount of irrigation ~~water~~ water that is the re e to ~~meet~~

$CIR = Cu - Re$

Cu = Cumtive use of water
Re = efficine rainfall during growth period of ~~crop~~ crop.

Cunstive used (Cu) / evapnat transpontation):

Before knowing we should have an idea of evaporation and transpontation}

Transpontation:

It is the process in which water entering the plant roots is used in building of plant tissue. ~~The~~ This ~~a~~ water finally passes into the atmosphere into form of vapour from the ~~[illegible]~~ of the plants.

Evapontation:

It is the crosses in which water from soil adjusent to the plant passes to the atmosphere in the form of vapour.

Evapo transpiration :

- When the crop is small water is predominantly lost by soil evaporation but once the crop is well developed and completely cover of soil transpiration of the main process.

- ~~as~~ Evapo transpiration is (Cu) is expressed is depth of water over an ~~ae~~ area in a given time period.

- It is Expressed in mm/day.

- Value of Cu varies of ~~B~~ crop to crop and also from the same crop ~~it~~ varies with as well as place.

Factors Affecting Consuming use :

I) Weather Parameter (Solar radiation, air temperature, wind speed)

II) Crop factor: (type of crop
~~Crop teach methode~~

III) Management and Co

Potential evapotranspiration: (PET)

PET is the amount of transpiration that will occured if an unlimited amount of water is available.

Actually Evapotranspiration:

- It is a actualy amount of evaporation that occure when water is limited.
- If water supply is less than (PET) soil, starts, brine hence, $\frac{\cancel{AET}\ AET}{PET}$
- For caly soil $\frac{\cancel{AET}\ AET}{PET} = 1$
- When the soil mositure riches ultimate wilting point AET = 0
- If suppley of water to the plant is not limited soil mositure will be field capacity AET = PET

Methods of determing Consutive use of water:

1) Direct Measurment:

a) Soil Mositure ~~a~~ study

b) lycimeter Method

c) Inflow and outflow Study

(ii) Emperical formulae :

a) ~~Bca~~ Blaney ~~~~ Method

b) ~~Hav g~~ Hargreaves pan evaporation Method

c) Modifyed Penman Method

2nd Module

Canal Irrigation:

- A canal is a artificial channel Constructed in ground to carry water from a river or from a reservoir for purpose like irrigation power generation etc.

- Canal and channel ~~things~~ is same things.
- Canals are usually having a trapezoidal crossection.

Classification of Irrigation Canals:

Base on nature of source of supply

(i) Parmanent Canal
(ii) Inundation Canal

Parmanent Canal is 2 types.

i) ~~Parentyal~~ Perennial canal
ii) Non-Perennial Canal

- The canal which is diverted from the bank of the inundation rivers to carry water to the agricultural land in rainy season only when the river flows to its full capacity is known as Inundation canal.

- The canal which as supply water to the agricultural land through out the Year is know as Perennial Canal.

from storage reserver to supply water to the network of other small canals is known as main canal.

- Branch canal :

The branch canals are taken from either side is main canal at suitable points show that the full command area can be covered by the network.

Distributery canal :

Distributary canal is at steman is from the branch canal to supply water to ~~the~~ different section.

Field canal :

The canal are taken from the outlet of the distributary canal by the cultivators to supply water to there own land

Fig: Canal System

Based on ~~channel alignment~~ Alignment:

~~It is a 2 types:~~

1) Ridge or water ~~side~~ side canal:

- The canal which is aligned along the ridge line is known as ridge canal.
- The advantage of this type of canal is that it can irrigate the areas on both sides.

Contour Canal:

- The canal which is aliged approximately parral to the Contour lines known as Contour Canal.
- This canal is irrigate the area on one side only.

• Side slope canal:

The Canal which is ~~all~~ aliged at [illegible] to the Contour line is known

a) Side slope canal

It can irrigate the area on one side

Based on purpose.

1) Irrigation canal:

The canal which is constructed to carry water from the source to the agricultural land for the purpose of irrigation is known as irrigation canal.

2) Navigation canal.

The canal which is constructed for the purpose of [illegible] is known as navigation canal.

3) Power canal:

The canal which is constructed to supply water with very high force to the hydroelectric power station for the purpose of generating electric power is called as power canal.

Feeder Canal :

The canal which is constructed to feed another canal or river is called feeder canal.

Canal Alignment :

- A canal should be aligned in such a way that it covers the entire area purpose to be irrigated which suites. Possible length or minimum cost of cross drainage work.

- ~~Main canal~~ Alignment of canal should be such that as far as possible a balance depth of cutting and filling is each achived.

Design of alluvial channels :

- In Indian alluvial channels are design on the basis of hypothetical theory given by ~~I~~ Kennedy and Lacey.

- In order to design a properly ~~the~~ functioning channel should be design for such a way that there is neither silting

non
non Scouring.

The channels in which neither silting nor scouring occours are called stable Channel. ~~Definition~~

Kennedy's theory:

- R.G. Kennedy in 1895 selected a number of sites on upper Bari Doab canal system for carrying out investigation about velocity and depth of channel.
- He selected some straight reaches of the canal section of a long period.
- On the basis of his observation Kennedy concluded the following statement.

i) Flowing water has to contend some amount of friction owing to the beds of canal.

ii) Friction to the flowing water gives rise to vertical eddies rising of gently to the surface.

iii) Generation of eddy are responsible for keeping most of silt is suspension.

~~Critical velocity of the Channel;~~

Canal alignment: Study

Definition of different terms related to the canal design:

Alluvial soil

The soil which is formed by the continuous deposition of ~~sheet~~ silt is known as alluvial soil.

Non-Alluvial soil:

The soil which is formed by the disintegration of ~~[illegible]~~ rock formation is known as non alluvial soil.

Silt factor (f)

- If designing of a ~~[illegible]~~ canal in alluvial soil the suspended silt and the deposited silt in the canal bed should be consider.

- The effect of silt on the determination of discharge and canal section silt factor as introduced.

- It depends ~~[illegible]~~ on min particle size of silt and denoted by (f).

$f = \cancel{[illegible]}\ 1.76\sqrt{M_R}$

M_R = Min particle size of silt in mm

... coefficient of velocity and it is denoted by N.

- The value of N depends on type of bed material of the canal.

Mean Velocity (V) :

- The velocity of flow measure by surface flow at all the depth of water in the canal or river is not constant. So it is found observation the the value at depth $0.6 \times D$ represent the mean velocity, where D is the depth of water in canal or river.

1st ~~Chezy~~

- Mean velocity by Chezy's equation

$$V = C \times \sqrt{R \times S}$$

Where V = Mean velocity M/Sec

C = Chezy's constant

R = Hydraulic Mean depth

S = Longitudinal Slop of depth

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~~In equation~~ :

Mean velocity by Mannings equation

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

Where N = Coefficient of ~~Ro~~

Critical Velocity (V_0) :-

When the velocity of flow is such that there is no silting and scouring action in the canal bed then that velocity is known as critical velocity. It is denoted by V_0 & According to Kennedy $V_0 = 0.546 \times D^{0.64}$

D = Depth of water

Critical Velocity Ratio (CVR)

- The Ratio of mean velocity to the Critical velocity is known as Critical velocity Ratio.
- It is denoted by ~~B~~ m

$m = \frac{V}{V_0}$

~~when~~ m = 1 there will be ~~no~~ silting or scouring ~~when~~ when m is < 1. Scouring ~~will~~ well occour.

Hence m is < 1 silting ~~so~~ when occour.

- When ... of the
bank materials of that of transported
- At same as that of and when the silt charge
material and when the silt charge
and silt grade are constant then the
channel is ~~said~~ set to be regime channel

Hydraulic mean depth / radius :

The ratio of the cross-sectional area of flow to the wetted perimeter of channel is known as hydraulic mean depth or radius. $R = \frac{A}{P_w}$

Where A = crossection area of flow

P_w = Wetted Perimeter

Full supply discharge :

- The maximum discharge capacity of the canal for which it is design is known as full supply discharge.
- The water level of the canal corresponding to the full supply discharge is known as Full supply level.

Economical section :

If a canal section is such that the earth cutting from cutting can be fully utilised in forming the bank then that section is known as that economical section.

Critical velocity in a channel :-

– According to Kennedy critical velocity V_0 is a channel can be defined as the mean velocity which will is just the channel free from silting & scouring.
He related critical velocity to depth.

– He introduced a factor to account for the type of soil through which the canal has to passed. This factor is known as critical velocity ratio.

– Equation for modify critical velocity

$V_0 = 0.55 \times m \times d^{0.64}$

Design procedure :

– Determine the critical velocity (V_0) by modify critical velocity equation by assuming a trial depth. trail depth is assumed 1m to 2m

– Determine area by dividing discharge (Q) by velocity (V)

– Velocity (V) is calculated by using Kutter & Manning formula.

- If $V = V_0$ = the assume depth is satisfaction.

→ Otherwise change the depth & repeat the above procedure while we have $V_0 = V$

i) Kutter's Formula:

$$\left[\frac{\frac{1}{n}+\left(23+\frac{0.00155}{S}\right)}{1+\left(23+\frac{0.00155}{S}\right)\frac{n}{\sqrt{R}}}\right]\sqrt{RS}$$

ii) Manning Formula:

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

iii) Generally Kutter's equation is used with Kennedy's theory.

Draw Backs:

1. The theory is limited to average regime channel only.
2. The design of channel is based on the ~~trio~~ trial and error method.
3. The value of 'm' was fixed arbitrarily.
4. Silt charge and silt grade are not consider.
5. There is no equation for determining

for bed slope and it depends on Kutter's equation only.

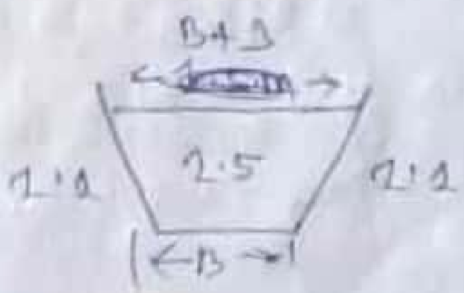
6. The ~~of B~~ ratio 'B' to 'D' has no significance in this theory.

— $\frac{B}{D}$ ratio is assumed between 3.52 to 12

Problem

Design an irrigation channel with the following data full supply discharge 6 cumec, ~~Rugosity~~ Rugosity coefficient (N) = 0.0225, CVR (m) = 1, Bed slope = $\frac{1}{5000}$.

Ans:



$Q = 6$ cumec

$n = 0.0225$

$m = 1$

$S = \frac{1}{5000} = 0.0002$

Let supply full supply

$D = \cancel{1}\ 1.5$ m

Side slope = 1:1

Bed width = B

Cross section area = $\frac{\frac{1}{2} B_1 + B_2}{2}$

~~CANAL~~ LINING
CANAL ~~LINE~~

Objective of canal lining:

The following are the main objective of main lining.

i) To control seepage:

The seepage lose is the maximum lose in online canals due to the seepage duty of canal water is most reduce which involves ~~[illegible]~~ enhancement of storage capacity of by constructing high dam. Thus the expend of the project in ~~[illegible]~~ include so to ~~[illegible]~~

ii) To prevent water logging:

Along the course of the can there may be low line areas on inside on both sides of the canal. Due to the seepage of water through the sides of the canal the area may get converted into marshy lands. This water logging makes the land alkaline which is unsuitable agriculture.

The water-lining also may be care the walls are responsible for many infectious diseas.

iii) To increase the capacity of canal

In online canal the velocity of flow should be fixed such that silting and scouring are avoided. In practice the velocity it should always be kept below 1 m/s. Due to the low velocity the discharge capacity of flow of canal of become low. In online canal if capacity of the canal is to be increased the cross-sectional area has to be increased which involves more land width. So lining of the canal should be such the velocity & discharge of canal are more with minimum cross-sectional area.

iv) To increase the command area:

If the lining is provided the various losses and ultimately the command area of the project may be increased.

v) To protect the canal from the damage by flood :

The entire canal may be saved the damage by scouring and erosion cost due to the highest velocity of at time of heavy rainfall. So to protect the canals from damage the lining should be provided.

vi) To control the growth of weeds.

The growth of various types of weeds along side of canal is a common problem. Here some types of weeds are found to grow along the bed of canal. These weeds reduce the velocity of flow and capacity of canal. So the lined canal required massive maintenance work for cleaning the weeds. The lining is provided in canal the growth of weeds can be stopped and capacity of canal may be increased.

Types of lining :

The following are different types of lining which are generally recommended according to various site condition.

1) Cement Concrete lining

~~The~~ This lining is recommended for the ~~[illegible]~~ canal in full banking. The cement ~~[illegible]~~ concrete lining is widely accepted as the best impervious lining. It can resist the effect of scouring and erosion very efficiently. The velocity of flow may be kept above 2.5 m/s. It can eliminate costly growth of weeds. The lining is done by the following.

1) Preparation of Subgrade:

Subgrade is prepared by ramming the surface ~~[illegible]~~ properly with the a layer of Sand about 5cm, then a of Cement & Sand in 1:3 is spread uniformly over the prepared bed.

2) Laying of Concrete :

The cement Concrete of grade M-15 is spread uniformly according to the design

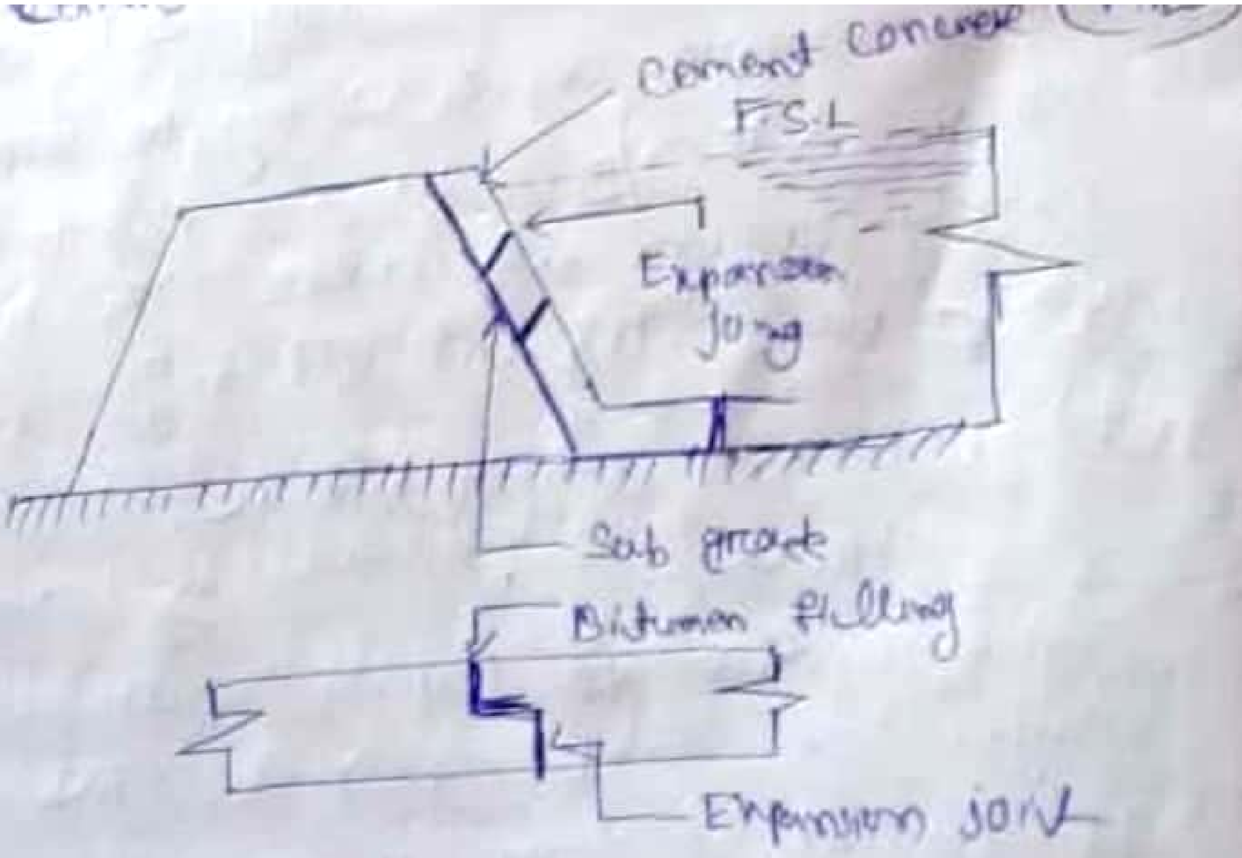


Fig : Cement concrete lining

PRE-CAST CONCRETE LINING :

The lining is recommended for the canal in full banking. It consists of pre cast concrete slab of size 60 cm x 60 cm x 5 cm which are set along a the canal bank and bed with cement mortar 1:6. A rebate of 6 mm diameter rod is provided in the slab with spacing 10 cm centre of centre, a proportion of 1:2:4. The slabs are set in the following sequence.

a) The subgrade is prepared by properly ramming the soil with a layer of sand ~~[illegible]~~

b) The bed is levelled so that the slabs be placed easily.

b) The slabs are stacked as per estimate along the course of the canal. The slabs are placed with cement mortar (1:6) by setting the rebate properly. The joints are finished with cement mortar.

c) The curing is done for a week.

CEMENT MORTAR LINING :

This type of lining is recommended for the canal fully in cutting where hard soil or clayey soil is available. The thickness of the cement mortar (1:4) is generally 2.5 cm. The sub-grade is prepared by ramming the soil after cutting

2nd Module

Water logging:

In agricultural lane when the soil pores within the root zone of the crops get saturated with the subsoil water the air circulation within the soil pores gets totally stopped. This phenomenon is known as water logging.

Causes of water logging:

i) Over Irrigation:

In inundation irrigation since there is no controlling system of water supply it may cause over irrigation. The excess water percolates and remains store with in the root case of stone. & In perennial irrigation system if water is supply more than what is required the excess water for man logging.

ii) Seepage from Canals:

In en-line canal system the water

Percolates through the bank of the canal and gets collected in the low laying area along the ~~course of the~~ course of the canal.

iii) Inadequate surface drainage:
When the rainfall is heavy and there is no proper provision for surface drainage the water gets collected and submerge when this condition is continue for long period the water level is raised.

iv) Obstruction in natural water flow:
If the bridge or culvert or water courses with the constructed area gets solar opening the obstruct area, gets the water logging and the cause the water logging.

v) Obstruction in sub soil drainage:
If some impermeable stratum exist at lower depth below the ground surface then the movement of the sub soil water gets obstructed and cause water logging the area.

(ii) Nature of soil:

The soil have been low permeability the black cotton soil cannot along the ... the percolate through it. So, in case of over irrigation on the water flood in water cause water logging.

7) Excessive rainfall:

If the rainfall in excessive water type to get up completive than a cond of ~~stagna~~ stagnant is form which may lead to water logging.

8) Occasional flood:

If an area gets affected area every year and there is no proper ... system the water to take ... ~~...~~ the ... water logging.

(B) Effect of water logging:

1) Salination of soil:

Due to water logging the ... salts sodium carbonate, sodium chloride come to the surface of the soil.

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When the water evaporate from the surface the salt ~~salt~~ are deposited there. This process ~~are~~ is known as Salination of Soil. Excessive the ~~the~~ can cause the same alkane at dovever & allow in plants of Survive. This the yield of crops in efflorescence.

2) Lack of ~~air~~ Aeration.

The crops requires some nutrients for their growth which are supplied by some bacteria or micro-organisms by breaking the complex nitrogeneous compound into simple compounds which are consumed by the plants for their growth. But the bacteria requires oxygen for their life and activity. When the aeration in the soil is stopped by water logging, these bacteria cannot survive ~~as~~ without oxygen and the fertility of the land is lost which results in reduction of yield.

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3) Fall of soil Temperature
Due to water logging the soil temperature is lowered. At low temperature of the soil the activity of the bacteria become very slow and consequently the plants do not get the requisite amount of food in time. Thus, growth of the plants is hampered and the yield also is reduced.

4) Growth of weeds and Aquatic Plants
Due to water logging, the agricultural land is converted to marshy land and the weeds and aquatic plants are grown in plenty. These plant consume the Soil foods in advance and thus the Crops are destroyed.

5) Diseases of Crops:
Due to low temperature and poor aeration, the crops

get some diseases which my destroy the crops or reduce the yield.

6) Difficulty in Cultivation:

In water logged area it is very difficult to carry out the operation of cultivation such as tilling ploughing etc.

7) Restriction of Root Growth:

When the water table rise near to root zone the soil gets saturated. The growth of the roots is confined only to the top layer on the soil so, the crops cannot be matured properly and the yield is reduced.

CONTROL OF WATER LOGGING (i.e ANTI WATER LOGGING MEASURESS)

The following measures may be taken to control water logging

1) Prevention of Percolation from Canals:

The irrigatio canals should be lined with impervious lining to prevent the Percolation of water through the bed and banks of the canals. Thus the water logging may be prevented.

Intercepting drains may be provided along the course of the irrigation canals in places where the percolation of water is detected. The percolating water is intercepted by the drains and the water is carried to other natural water course.

2) Prevention of percolation from Reservoirs:

During the construction of dam the geological survey should be conducted on the reservoir basin to detect the zone of permeable formation through which water may percolate. These zones should be treated properly to prevent the seepage. If afterwards it is found that there is still leakage of water through some zone, then sheet piling should be done to prevent the leakage.

3) Control of Intensity of Irrigation:

The intensity of irrigation may cause water logging so, it should be controlled in a planned way so that there is no possibility of water logging in a particular area.

4) Economical use of water:

If the water is used economically, then it may control the water logging and the yield of crops may be high. So, special training is required to be given to the cultivators to realise the benefits of economical use of water. It helps them to get more crops by eliminating the possibility of water logging.

5) Fixing of crop pattern:
Soil survey should be conducted to fix the crop pattern. The crops having high rate of evapotranspiration should be recommended for the area susceptible to water logging.

6) Providing Drainage system:
Suitable drainage system should be provided in the low lying areas so that the rain water does not stand for long days. A net work of sub-surface drains are provided which are connected to the surface drains. The surface drains discharge the water to the river or any water course.

7) Improvement of Natural Drainage:
Sometimes, the natural drainage may be completely silted up or obstructed by weeds, aquatic plants, etc. The affected

of the drainage should be improved by excavating and cleaning the obstruction.

8) Pumping of ground water:

A Number of open wells or tube wells are constructed in the water logged area and the ground water is pumped out until the water table goes down to a safe level. The lifted ground water may be utilised for irrigation or may be discharge to the river or any water course.

9) Construction of sump well:

Sump wells may be constructed within the water logged area and they help to collect the surface water. The water from the sump wells may be pumped to the irrigable lands or may be discharged to any river.

* LAND RECLAMATION:

The reclamation of land is the process of making a land culturable after it gets converted to unculturable area due to the bad effect of water logging. The following are the general methods of land reclamation,

2) Addition of Chemical Agent :

3)

4)

5)

6)

7)

CROSS DRAINAGE WORK:

In an Irrigation Project when the network on main canals, branch canals, distributary etc are provided these canal may have cross the natural drainage like river, stream, Nala etc. at different point within the command area of the project.

→ The crossing of the canals with such obstacle cannot be avoided, so suitable structure must be constructed at the crossing point for the easy flow of water of the canal & drainage in the respective direction this structure are known as cross drainage work.

→ But the nature of drainage work may be different at differnt place. Sometime the bed level of canal may be below the bed level of the drainage & sometime it may be higher than that of the drainage.

→ The bed level of the canal may be nearly same also. So the structure are different at different place & the designation of the structure also different!

* Neccessity of cross drainage works:

The following factor justifyed the Neccessity of cross drainage works:-

1) The water is canal donot cross natural canal but in actual orientation of the canal level. The canal conditiy may be avoided and may be presend across the canal, so the cross drainage work must be provided

2) At the crossing point the water of the canal get into mix. So, for the smooth running of the cross drainage work its design work. The ~~stge~~

3) The site condition of the crossing point may be such that without any suitable structure the water of the canal or drainage cannot be diverted to that natural draination. So the cross

Dramage

a) Aqueduct :

The hydraulic structure in which the irrigation canal is taken over the drainage is known as aqueduct.

This structure is suitable when bed level is above the hight flood level of drainage. In this case the drainage water passes clearly below the canal.

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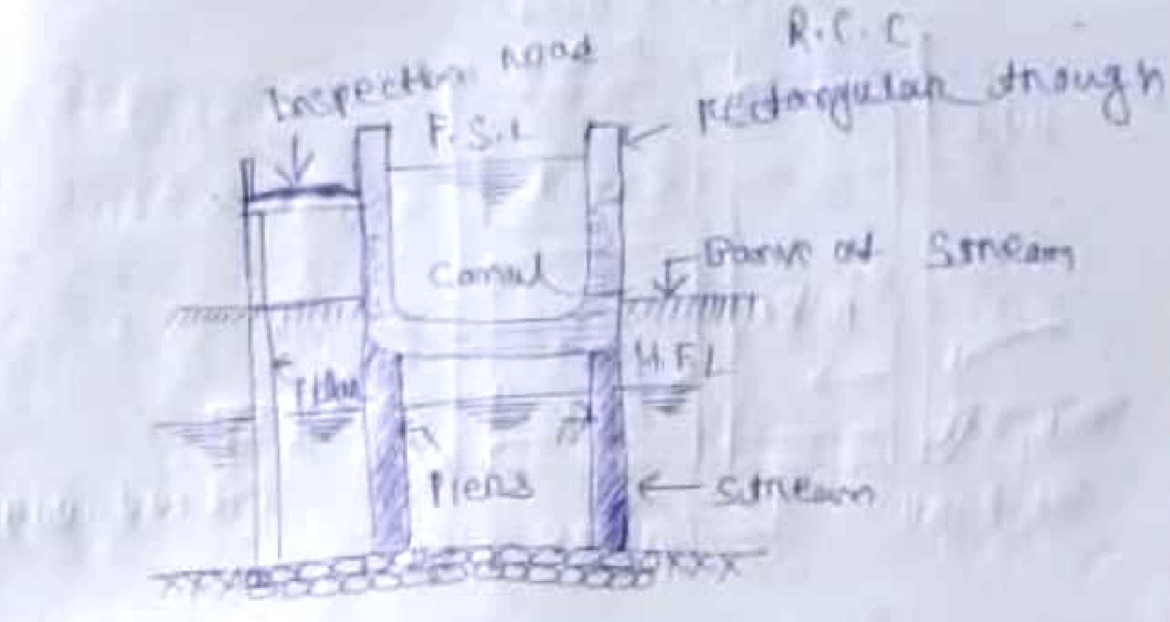
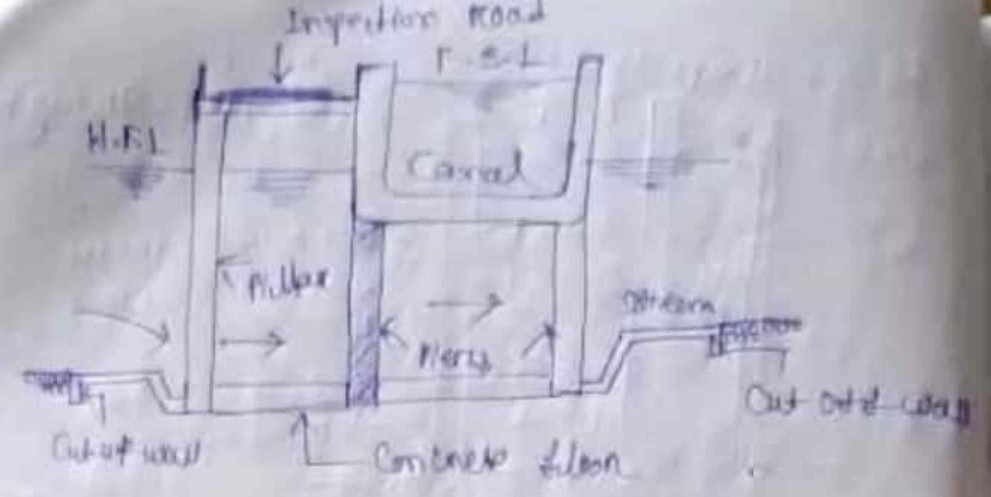


Aqueduct

b) Siphon Aqueduct :

It is a hydraulic structure where the canal is taken over the drainage but the drainage water cannot pass clearly below the canal.

In this case the bed of the drainage is depressed below the bed level of the canal. The drainage water ~~flows~~ flow under the ~~this structure~~ siphonic action. So it is known as siphon Aqueduct. This structure is suitable when the bed level is canal is below the high flood level drainage.



Sithon Aqueduct

Type - 2

Drainage Passes over the Irrigation Canal !

Super Passage :-

The super passage is just opposite of Aqueduct. The hydraulic Structure in which the drainage is taken over the irrigation canal is known as Super passage.

This Structure is suitable when the bed level of drainage above the full supply of the canal. The water of the canal passage clearly below the drainage.

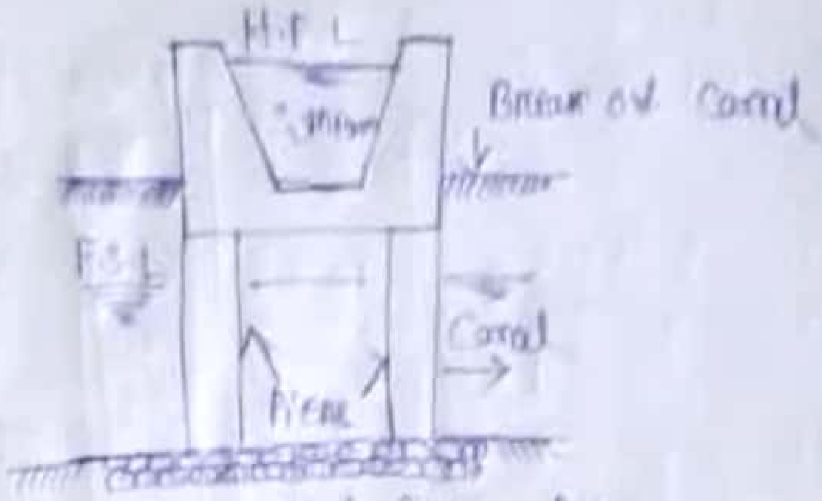


Fig: Super Passage

* Siphon Super Passage :

It is just opposite of siphon aqueduct. The Hydraulic structure in which the drainage is taken over the irrigation canal but the canal water passes below the drainage under siphonic action is known as siphonic Superpassage. This structure is suitable when the bed level of drainage is below the full supply level of canal