IRRIGATION ENGINEERING &PRACTICE

Final Assignment/Quiz

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Subject: Irrigation Engineering and Practice

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Ans#1: Part:a: Define Delta and Duty

Delta: Each crop requires a certain amount of water after a certain fixed interval of time ,through out its growth period. the depth of water required varies from 5 cm to 10 cm depending upon type of crop ,climate etc

The total quantity of water required by the crop for its full growth(maturity) throughout the crop period is called Delta.

The Depth of water in(inches or cm) for the crop throughout the base period is called Delta of the crop

Duty: The duty of water is the relationship between the volume of water and the area of the crop its matures.

Of land irrigated for full growth of a given crop by supply of 1 m^3 /sec of water continuously during the the entire base period(B) of the crop.

Thus if a water flowing at a rate of one cubic meter per second runs continuously for B days and matures 200 hectares per cumes to the base of B days.

Q#1Part#b:

Given data:

Depth of water=10 cm

Crop period=140 days

Interval=35 days.

Required=find out the delta

Solution:

Water is required at an interval of 35 days for a period of 140 days .

So it means that 140/35 =4 no of watering are required

As each time 10 cm depth of water is required

so therefore the total depth of water required=4*10=40 cm

So Delta for wheat is =40 cm Ans

PartC: Factors effecting consumptive use :

Many factors operate singly or in combination to influence the amounts of water consumed by plants. Their effects are not necessarily constant, but the factors may differ with locality and water consumption may fluctuate from year to year. Some effects involve the human factor; others are related to the natural influences of the environment and to the growth characteristics of the plants.

The more important of the natural influences are climate, water supply, soils, and topography. The climatic factors that particularly affect consumptive use are temperature, solar radiation, precipitation, humidity, wind movement, length of growing season, latitude, and sunlight. Data were not available for solar radiation.

1. PRECIPITATION

The amount and rate of precipitation may have some minor effect on the amount of water consumptively used during any summer. Under certain conditions, precipitation may occur as a series of frequent, light showers during the hot summer. Such showers may add little or nothing to the soil moisture for use by the plants through transpiration but do decrease the withdrawal from the stored moisture. Such precipitation may be lost largely by evaporation directly from the surface of the plant foliage and the land surface.

Part of the precipitation from heavy storms may be lost by surface runoff. Other storms may be of such intensity and amount that a large percentage of the moisture will enter the soil and become available for plant transpiration. This available soil moisture may materially reduce the amount of irrigation water needed.

2. TEMPERATURE

The rate of consumptive use of water by crops in any particular locality is probably affected more by temperature, which for long-time periods is a good measure of solar radiation, than by any other factor. Abnormally low temperatures retard plant growth and unusually high temperatures may produce dormancy. Consumptive use may vary widely even in years of equal accumulated temperatures because of deviations from the normal seasonal distribution. Transpiration is influenced not only by temperature but also by the area of leaf surface and the physiologic needs of the plant, both of which are related to stage of maturity.

3. HUMIDITY

Evaporation and transpiration are accelerated on days of low humidity and slowed during periods of high humidity. During periods of low relative humidity, greater rate of use of water by vegetation may be expected.

4. WIND MOVEMENT

Evaporation of water from land and plant surfaces takes place more rapidly when there is moving air than under calm air conditions. Hot, dry winds and other unusual wind conditions during the growing period will affect the amount of water consumptively used. However, there is a limit in the amount of water that can be utilized. As soon as the land surface is dry, evaporation practically stops and transpiration is limited by the ability of the plants to extract and convey the soil moisture through the plants.

5. GROWING SEASON

The growing season, which is tied rather closely to temperature, has a major effect on the seasonal use of water by plants. It is frequently considered to be the period between killing frosts, but for many annual crops, it is shorter than the frost-free period, as such crops are usually planted after frosts are past and mature before they recur.

For most perennial crops, growth starts as soon as the maximum temperature stays well above the freezing point for an extended period of days, and continues throughout the season despite later freezes. Sometimes growth persists after the first so-called killing frost in the fall. In the spring, and to less extent in the fall, daily minimum temperatures may fluctuate several degrees above and below 32° F. for several days before remaining generally above or below the freezing point. The hardier crops survive these fluctuations and continue unharmed during a few hours of subfreezing temperature. In fact, many hardy crops, especially grasses, may mature even though growing season temperatures repeatedly drop below freezing. In southern Arizona and California alfalfa and citrus trees grow throughout the year.

6. LATITUDE AND SUNLIGHT

Although latitude may hardly be called a climatic factor, it does have considerable influence on the rate of consumptive use of water by various plants. Because of the earth’s movement and axial inclination, the hours of daylight during the summer are much greater in the northern latitudes than at the Equator. Since the sun is the source of all energy used in crop growth and evaporation of water, this longer day may allow plant transpiration to continue for a longer period each day and to produce an effect similar to that of lengthening the growing season.

7. AVAILABLE IRRIGATION WATER SUPPLY

All the above-mentioned climatic factors influence the amount of water that potentially can be consumed in a given area. However, there are other factors that also cause important differences in the consumptive use-rates. Naturally, unless water is available from some source (precipitation, natural ground water, or irrigation), there can be no consumptive use. In those areas of the arid and semiarid West where the major source is irrigation, both the quantity and seasonal distribution of the available supply will affect consumptive use. Where water is plentiful and cheap, there is a tendency for farmers to overirrigate. If the soil surface is frequently wet and the resulting evaporation is high, the combined evaporation and transpiration or consumptive use may likewise increase. Also, under more optimum soil moisture conditions, yields of crops such as alfalfa may be higher than average and more water consumed. In irrigating some crops, such as potatoes, water is applied to the field not only for the purpose of supplying the consumptive water needs of the crop but also to help maintain a favorable microclimatic condition.

8. QUALITY OF WATER

Some investigations have shown that the quality of the water supply may have an appreciable effect on consumptive use. Whether or not plants actually transpire more or less if water is highly saline may be debatable. However, if it is necessary to apply additional water to the land to leach the salts down through the soil, more water will probably be lost by evaporation from the soil surface and such loss will be chargeable against the consumptive requirement of the cropped area.

9. SOIL FERTILITY

If a soil is made more fertile through the application of manure or by some other means, the yields may be expected to increase with an accompanying small increase in use of water. However, an increase in fertility of the soil causes a decrease in the amount of water consumed per unit of crop yield.

10. PLANT PESTS AND DISEASES

Where plant pests and diseases seriously affect the natural growth of the plants, it is reasonable to assume that transpiration will likewise decrease. It is recognized that some damage to crops is caused every year by pests and diseases. Ordinarily the losses may not vary greatly from year to year, but in those years when they are unusually severe consumptive use may be lowered materially.

End Of Question#a part b and c

Ans#2 parta: What are the causes and ill effects of water logging.

Causes of water logging:

An agricultural land is said to be water logged when its productivity get affected by the high water table.

The productivity of land infect, gets affected when the root zone of the plants gets flooded with water and thus become ill-aerated. Ill aeration reduces crop yield

Causes of water logging:water logging is the rise of water table which may occur due to the following factors

1.Over and intensive irrigation.when the policy of intensive irrigation is adopted, then the maximum irrigable area of a sall region is irrigated .this lead to too much of irrigation in that region,resul in heavy percolation and subsequesnt rise if water table.

2.Seepage of water from the adjacent :water from the adjoining high lands may seep into the sub soil of the affected land and may rise the water table

3.Seepage of water through the canals.

Water may seep through the beds and sided of the adjoining canal ,reservoirs etc. situated at a higher level than the affected land resulting in high water table.

4.Impervious obstructions: water seeping below the soils moves horizontally but may find an impervious obstruction causing rise of water table on the upstream side of obstruction.

5. indequet natural drainage.

Soils habving less permeable sub stratum below the top layers of pervious soil,will not be able t ordain the water deep into the groung result in high water table in the effected soil

6.Inidequet surface drainage: strom water falling over the land and the excess irrigation water should be removed and should not be allowed to percolate below.if proper drainage is nt provided the water will constantly percolate and will rise the level.

7.Excessive rains:Excessinve rains may creat temporary water logging and in the absence of good drainage.

8.Submergence due to flood.

I f land continuously remain submerged by floods ,

9.Irrigullar or Flat Topograpghy.

In steep terrain the water is drained out quickly.

Ill Affects of water logging:

I. The normal cultivation operation such as tilling ,ploughing etc cannot be easily carried out in the soil
II. Certain water loving plants like grasses ,weeds etc grow profusely and luxuriantly in water logging land, thus affecting and interfering with the growth of the crops.
III. Water logging also leads to salinity if the water table hase risen up or if the plants roots happen to come within the capillary fringe water is continuously evaporated by capillarity thus a continuous upward flow of water from the water table to the land surface gets establish with this upward flow ,the salt which are present in the water also rise towards the surface resulting in the deposition oof salt on the rot zone.

Q#2partb:Anti water logging measures.

It is evident that water logging can controlled only if the quantity of water into the soil below is checked and reduced.

To achieve this the inflow of water into the underground reservoir is checked and reduced and the outflow of water into the underground reservoir should be increased as to keep the highest position of water table at least about 3 m below the ground surface.

There are various measures adopted for controlling water logging which are discussed below.

1. **Lining of canals and water courses.**to reduce the water seepage from canals and water courses is achieved by lining them and is a very effective method to control water logging.
2. **Reduced the intensity of irrigation.**In areas where there is a possibility of water logging intensity of irrigation should be reduced only a small portion of irrigable land should receive canal water in one particular season.
3. **By introducing crop rotation.**certain crops require more water and other require less water .in order to avoid this a high watering requiring crop should be followed by one requiring less water.
4. **Optimize use of water.**it is a known fact that only a certain fixed amount of irrigation water gives best productivity .less than that and more than that reduce the productivity.
5. **By providing intercepting drains.**an efficient drainage system should e provided in order to drain away the storm water and excess irrigation water.
6. **By improving the natural drainage of the area.**the the percolationg the water should not be allowed to stand for a longer period.
7. **By adopting consumptive use of surface and subsurface water.** the introduction of lift irrigation to utilize ground water helps in lowering the water table.

Q#2 partC:

Reclamation is the process by which an uncultivable land is made fit for cultivation saline and water logged lands gives very less crop yield and therefor are unfit for cultivation, unless they are reclaimed.

Every agricultural land contains certain mineral salt in it some of these salts are beneficial for plants while certain other prove injurious to plant growth and there common examples are Na2Co3,Na2So4 and Nacl .Na2co3 or black alkalis the most harmfull.

Reclamation of Saline lands Alkali salts (Sodium chloride, Sodium Sulphate, and Sodium Carbonate) are injurious to agriculture. NaCl-------- Least harmful Na2SO4-----Medium harmful Na2CO3------Most harmful • The above salts are soluble in water • When W.T rises up or roots are in capillary zone, the G.W moves upwards and salts are deposited in root zone and surface of soil

The phenomena of salts coming up in solution and forming a thin crust (5-7.5cm) on the surface after evaporation of water is called Efflorescence Land affected by efflorescence is called saline soil Salts surrounding the roots reduce the osmotic activity of plants.

By principle of Osmosis, the pure water from root flows outwards in a plant die due to lack of water • Such soil is unproductive and is called Saline soil. • If the salt efforescence continues for a longer period, a base exchange reaction with clay takes place, thus Sodiumizing the clay, making it impermeable, ill aerated and highly unproductive. • Such soil are called alkaline soils

Reclamation of Salt affected lands How to avoid efforescence? • By maintaining the water table sufficiently below the roots • Hence all the measures which were suggested for preventing water logging hold good for preventing salinity of lands • An efficient drainage (surface and subsurface) must be provided to lower the water table in saline soils

LEACHING

In this process; 1) Land is flooded with water 2) Alkaline salts will be dissolved in water 3) Percolation to the ground water 4) Drained by sub surface drains • High Salt resistant crops like rice are grown on leached land for 1 or 2 seasons • Then ordinary crops like wheat or cotton are grown

• Then the land is said to have reclaimed • When Sodium carbonate is present in the soil, gypsum is added before leaching • Sodium sulphate is formed which is leached out easily

Na2CO3+CaSO4--------->>Na2SO4+CaCO3 Land drainage 1. Surface drainage 2. Subsurface drainage/Tile drainage

Surface Drainage

• Removal of excess of water using open ditches, field drains, land grading etc. • Open drain which remove excess of irrigation and storm water are broad and shallow are called shallow surface drains. • Shallow surface drains carry runoff to point of entrance to outlet-ditches. These Large and deep outlet ditches are called deep surface drains.

Land Grading

• It is a continuous land slope towards field drains. • It is necessary for surface irrigation. • DEEP SURFACE DRAINS OR OUTLET DITCHES: They carry the seepage water from tile drainage. They carry storm water and excess of irrigation water. They are designed for combined discharge.

End Of Question#2 part a and b and c

Q#3

Part#a How does Kennedy's theory differ from Lacey's theory for the design of irrigation canals?

Ans:

Comparison of Kennedy's and Lacey's Theories and Improvements over Lacey's Theory.

(1) The concept of silt transportation. is the same in both· the cases. Both the theories agree that the silt is carried by the vertical component of the eddies generated by the friction of the flowing water against the channel surface. The difference is that Kennedy considered a trapezoidal channel section and, therefore, he neglected, the eddies generated from the sides, on the presumption that these eddies has horizontal movement for greater part and, therefore, did not have silt supporting power. For this reason, kennedy's critical velocity formula was derived only in terms of depth of flow (y). On the other hand, Lacey considered that an irrigation channel achieves a cup shaped section (semi-ellipse) and that the entire wetted perimeter (P) of the channel contributes to the generation of silt supporting eddies. He, therefore, used hydraulic mean radius (R = ~ J as a variable in his regime velocity formula instead of depth (r).

(2) Kennedy stated all the channels to be in a state of regime provided they did not silt or scour But, Lacey differentiated between the two regime conditions, i.e. Initial regime an~ final regime.

(3) According to. Lacey, the grain size of the material forming the channel is an important factor and should need much more rational attention than what was given to it by Kennedy. Kennedy has simply stated that. Critical velocity ratio (V IV0 = nz) varies according to the silt conditions (i.e. silt grade and silt charge).

Lacey, however, connected the grain size (d) with his silt factor (j)

by the. equation f = 1.76 dmm • The silt factor (j) occurs in all those Lacey's equations, which are used to determine channel dimensions.

(4) Kennedy has used Kutter's formula for determining the actual generated channel velocity. The .value of Kutter's rugosity coefficient (n) is again a guess work. Lacey, on the other hand, after analysing huge data on regime channels, has produced a general regime flow equation, stating that V= 10.8 R^2/3 S^1/3

(5) Kennedy has not given any importance to bed width and depth ratio. Lacey has connected wetted perimeter (P) as well as area (A) of the channel with discharge, thus, establishing a fixed relationship between bed width and depth.

(6) Kennedy did not fix regime slopes for his channels, although his diagrams indicate·that-steeper-.slopes –are required for smaller· channels and flatter slopes are required for larger channels. Lacey, on the other hand, has fixed the regime slope, connecting it with discharge by the formula given by eqn. as

This regime slope formula, given by Lacey, gives excessive slope values. Not even a single channel has been constructed according to this regime slope equation; either on the lower Chenab Canal System or on the Lower Bari Doab Canal System or on the Jhelum Canal System.

Ans#3Part#b :

(a) Design a regime channel for a discharge of 30 cumecs and mean diameter of the particle of 0.56 mm using Lacey's theory.

Ans:

Given data:

Q= 30cumec/sec

D mm=0.56m

Required = design

Solve : As we know

$V = \left(\frac{Qf2}{140}\right)^{1/6}$

as f=1.76 $\frac{\sqrt{\text{d mm}}}{}$

so f= 1.76 $\frac{\sqrt{0.56}}{}$

f= 1.31

so v= $\left(\frac{30\ x\ (1.31)2}{140}\right)^{1/6}$

=084m/sec

A 30/0.84 = 35.46m^2

R =5/2. V^2/f

$=5/2\ (0.846)^2/1.31.$

$=1.36m$

$P= 4.75\frac{\sqrt{q}}{}$

$= 4.75\ \frac{\sqrt{30}}{}$

$= 26.01m$

For a trapezoidal channel with

1/2 H : 1 V Slopes.

$P= B + \sqrt{5}\ y$

$A = [b+y/2]y$

$26.01=b+\sqrt{5}\ y$……………..(i)

$35.46= by + y^2/2$…………..(ii)

From Equation (i)

$B = 26.01 – 2.24\ y$ Putting the values in equation (ii)

$35.46=[26.01-2.24y]\ y+y^2/2$

$=26.01y-2.24y^2+0.5y^2$

$=26.01y-1.74y^2$

$=1.74y^2-26.01y+35.46=0$

$Y^2-14.94y+20.37$

$Y=14.94\frac{\pm\sqrt{223.20-81.48}}{2}$

$Y= \frac{14.94\pm 11.90}{2}$

$Y= \frac{14.94\pm 11.90}{2}$

$Y=1.52$

So $b= 26.01-2.24 \times 1.52$

$B=22.60m$ Ans

End of Question3 part a and B

Q4: Writes notes on the following:

(a) Field Capacity

(b) Permanent wilting point

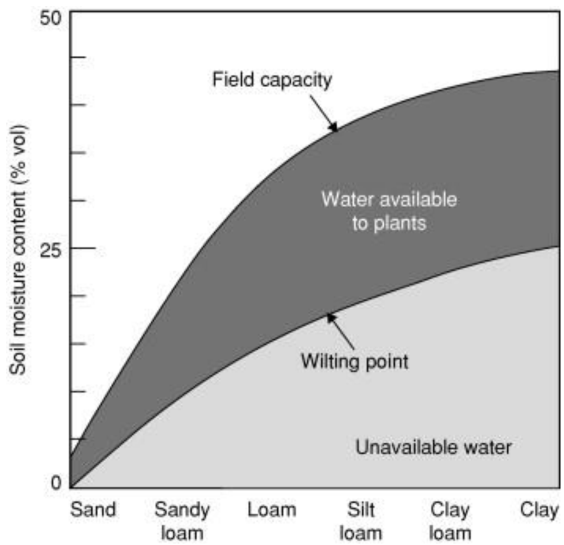
(c) Canal Head Regulator

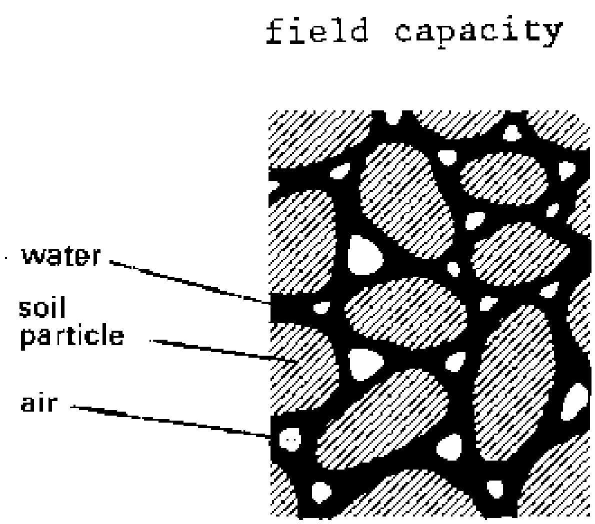
(d) Uder Slucies.

Ans:

(a) Field Capacity:

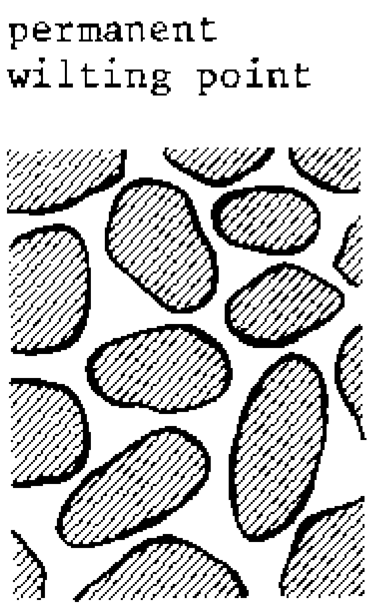
When all gravity water has drained down to water table, a certain amount of water is retained by surface soil. This water which cannot be easily drained under the action of gravity so it is called field capacity. Its period of drainage is 2 – 5 days and field capacity (FC) is also measured after 2 or 5 days. After the drainage has stopped, the large soil pores are filled with both air and water while the smaller pores are still full of water. At this stage, the soil is said to be at field capacity. At field capacity, the water and air contents of the soil are considered to be ideal for crop growth as shown in fig below.
Capillary water: that water which attached to soil by surface tension, which can easily be extracted by plants by capillary action.
Hygroscopic water: water attached to soil by chemical bonds, which cannot be extracted by plants by capillary action.
Mathematically it is written as:
Field Capacity= (weigh of water retained in a certain volume of soil)/wt. of same volume of soil) x 100.





(b) ***Permanent wilting point:***

A plant can extract water from soil till a permanent wilting is reached. Permanent wilting point is that water content at which a plant can no longer extract sufficient water for its growth and wilts up.
Mathematically water available to plant = Field capacity – permanent wilting point
Little by little, the water stored in the soil is taken up by the plant roots or evaporated from the topsoil into the atmosphere. If no additional water is supplied to the soil, it gradually dries out.
The dryer the soil becomes, the more tightly the remaining water is retained and the more difficult it is for the plant roots to extract it. At a certain stage, the uptake of water is not sufficient to meet the plant's needs. The plant looses freshness and wilts; the leaves change colour from green to yellow. Finally the plant dies.
The soil water content at the stage where the plant dies is called permanent wilting point. The soil still contains some water, but it is too difficult for the roots to suck it from the as shown in fig. below:



(c) Canal Head Regulator:

A structure which is constructed at the head of the canal to regulate the flow of water is known as canal head regulator. It consists of a number of piers which divide the total width of the canal into a number of spans which are known as bays. And the piers consist of number tiers on which the adjustable gates are placed. The gates are operated from the top by suitable mechanical device. Also a platform is provided on the top of the piers for the facility of operating the gates. Again some piers are constructed on the downstream side of the canal head to support the roadway.
The function of the canal head regulator is to regulates the supply of water into canal, control the entry silt into canal and prevents the entry of floods into canal.
It is also define as the Structure at the head of canal taking off from a reservoir may consist of number of spans separated by piers and operated by gates. Regulators are normally aligned at 90° to the weir.

Up to 10" are considered preferable for smooth entry into canal. The functions of canal head regulator are:
To admit water into the off taking canal.
To regulate the supplies into the canal.
To indicate the discharge passed into the canal from design discharge formula and observed head of water on the crest.
To control the silt entry into the canal. During heavy floods, it should be closed otherwise high silt quantity will leave to the canal.
Types of canal head regulator
Following are the common types of Canal Head Regulator:
Still pond regulation:
Open flow regulation
Silt control devices

Still pond regulation:
Canal draws water from still pond
Water in excess of canal requirements is not allowed to escape under the sluice gates.
Velocity of water in the pocket is very much reduced; silt is deposited in the pocket
When the silt has a level about 1/2 to 1m below the crest level of Head Regulator, supply in the canal is shut off and sluice gates are opened to scour the deposited silt.

Open flow regulation
Sluice gates are opened and allow excess of the canal requirement
Top water passes into the canal
Bottom water maintain certain velocity in the pocket to keep the silt to remain in suspension
Canal is not closed for scouring the silt.

Silt control devices
Another type of Canal Head Regulator is the silt control device
Silt control at head works can be controlled by Providing a divide wall to Create a trap or pocket
Create scouring capacity of under sluices By concentrating the currents towards them
Paving the bottom the approach channel to reduce disturbance because due to disturbance sediment remains in suspension.

Canal Head Regulator

(d) Under sluices:

The under sluices are the opening provided at the base of the weir or barrage. These opening are provided with adjustable gates. Normally the gates are kept closed. The suspended silt goes on depositing in front of the canal head regulator. It is also called scouring sluices. When the silt decomposition becomes appreciable the gates are opened and the deposited silt is loosened with an agitator mounting on a boat. The muddy water flows towards the downstream through the scouring sluices. Finally the gates are then closed. But at the period of the flood the gates are kept opened. Under sluice sections are provided adjacent to the canal head regulators. The under sluices should be able to pass fair weather flow for which the crest shutters on the weir proper need not be dropped. The crest level of the under sluices is generally kept at the average bed level of the river.

Functions of under sluices are:

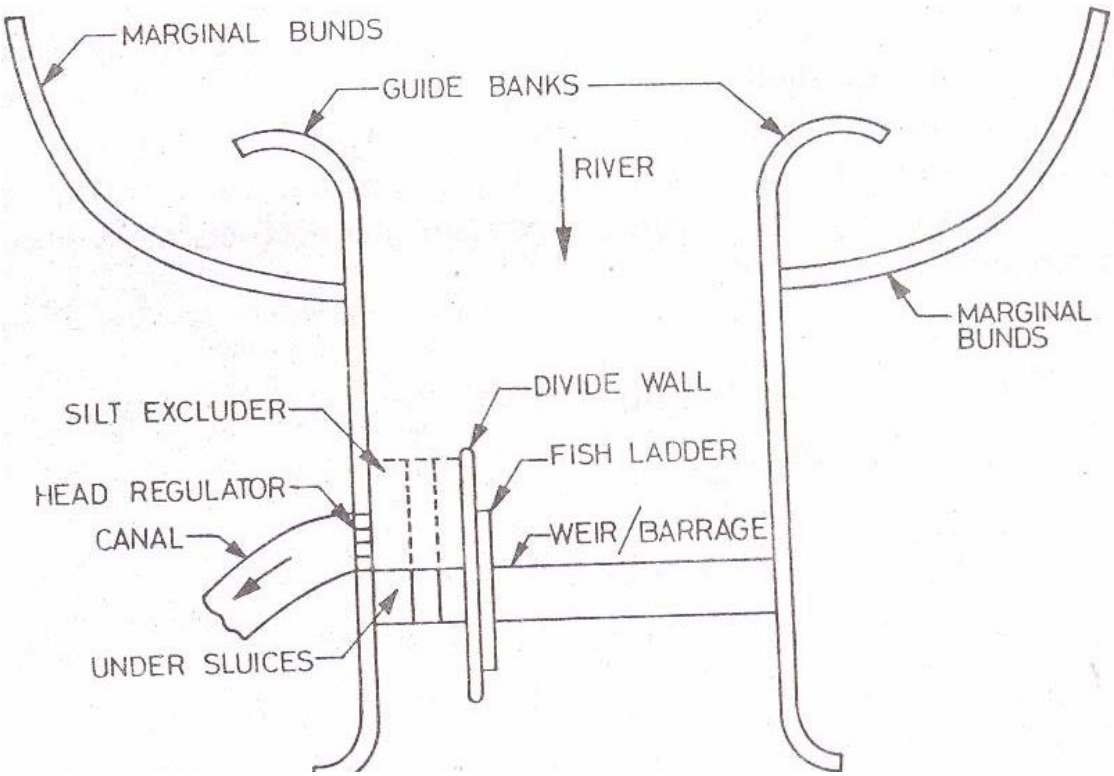
i) Preserve a clear and defined river channel approaching the regulator.

ii) Control the silt entry into the canal.

iii) Pass the low floods without dropping the shutter of the main weir.

iv) Provide greater water-way for floods, thus lowering the flood level.

v) They scour the silt deposited on the river bed above the approach channel



End of question 4 part 1 and 2