⊛ IRRIGATION ENGINEERING AND ⊛ PRACTICES

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Q1) i) Define Delta & Duty of crop and write its significance.

⊛ Delta

The total quantity of water required by the crop for its full growth may be expressed in hectare-metre / depth to which water withstand on irrigated area, if the total quantity supplied were to stand above the surface without percolation. This total depth of water is called delta(Δ) of crop.

⊛ Duty

It may be defined as the number of hectares of land irrigated for full growth of a given crop ~~of the~~ ~~area of land~~ can 1m³/s of water continuously during the entire base of that crop.

→ factors are various that effect duty of crop such as

- Type of soil
- Efficiency of cultivation method
- Climate and season
- Type of crop

→ Relationship among the following

- The area of crop that it cultivates
- Volume of water.

Importance of Duty & Delta / Significance

Its most important pros is that it helps in designing an efficient canal irrigation system. In the total available water at the head of main canal and also overall duty for all crops in different Seasons of the year are known we can determine the area which can be irrigated.

On another hand, if we know the crops area required to be irrigated and their duties, we can determine discharge required for designing a channel.

Q(1) (b)

Given Data

Base Period = 140 days.

Depth of water = 10 cm

No of Days = 35 days.

Solution

Base period = 140 days.

No of watering required = $140/35 = 4$

Total depth of water required in 140 days =

$= 10 * 4 = 40$ cm

Therefore,

Delta of wheat = 40 cm.

(1)(C) Explain Factors Affecting Consumptive Use. ③

Consumptive use is the sum of two processes.

① Evaporation

② Transpiration

There are several factors that effect both the Evaporation & Transpiration, which has a direct effect upon consumptive use. The Factors that effects are as follows.

① Evaporation

- Humidity
- Wind Speed
- Temprature of soil & air
- Vegetation cover
- Saturation of Soil

② Transpiration

Transpiration is effected by three major factors. which are as follows.

① Climate Factors
② Soil Factors
③ Plant Factors

① Climatic Factors.

- Temprature
- Humidity
- Wind Speed
- Atmospheric Vapor Pressure
- Duration & Intensity of light

② Soil Factors:

- Moisture content
- Hydraulic conductivity
- Texture
- Structure.

Plant Factors.

- Leaf Arrangment
- Leaf structure
- Stomatal behavior
- Efficiency of root system.

Q.No(8) (a) What are the principal causes and ill effects of water logging? ⑤

Water logging: water logging is termed as when the higher water table of the land effects the productivity of land. This leads to saturation of root zone, resultantly it decays the nitrifying bacteria. This results in low crop yield.

Principal Causes of water logging

① Excessive Rainfalls → This causes temporary water logging in the land. If there is no drainage of the land the water logging becomes permanent.

② Inadequate Surface Drainage
If surface drainage is not proper the storm water or excess of irrigation water percolates into land which results in rise of water table.

③ Impervious Obstruction
The water seeps into the land horizontally. It may find obstructions in the soil strata which results in the rise of water table.

④ Seepage of Water through Canal Reservoirs.
If there is seepage from a reservoirs continuously it results in high water table.

⑤ Seepage of water from adjoining high land is also the cause of water-logging.

⑥ Irregular & Flat Topography.
If there are depressions in the topograp[hy] water accumulates in the depression causing more infilteration

ich would lead to higher water table.

7) Intensive Irrigation

If large areas of lands are irrigated The more would be percolation of water to the underlying land This causes the rise in water table.

8) Submergence due to Floods.

Continuous floods causes growth of water loving plants that obstruct the surface drainage and increases the water-logging.

*) Ill effects of water-logging

ill effects of water-logging are as follows.

① Poor Soil Aeration → water logging causes the air within the soil to move out into the atmosphere replacing it with more water which causes retardation in supply of oxygen and seizes growth of plant.

② It Alters PH of Soil : In flooded soils the PH changes and becomes more acidic making growth of plant difficult.

③ Change in Soil Temprature. water logging lowers the temprature of soil which effects the microorganisms subsequently lowering the rate of nitrogen fixation.

④ Affecting Soil Nutrients: water logged soil suffer from nitrogen deficiency which causes retardation in growth.

⑤ Retard Cultivation : There is difficulty in cultivating in water logged soils.

Growth of weed: water logging causes wild ⑦
plants like weeds to grow. These weeds effectively kill useful crops.

⑦ Loss of Cash Crops: Most cash crops cannot survive or be cultivated in water logged soils. It makes farmers loose out on cash crops.

(b) Describe anti-water logging measures? (8)

(A) Anti- Water logging Measures.

Measures that would help in controlling the water-logging are described as follows;

① Installation of Tube Wells;

Lift irrigation should be adopted in the areas which have higher water table, instead of ground water. Canal irrigation system should be substituted by the tube-well irrigation

② Inundation Canals.

The canals which are are not lined should be properly lined in order to prevent the water from percolation to the ground.

③ Decreasing Intensity of Irrigation.

The irrigation of the land should in rotation such that one part of the land in one season while the remaining area of the land can receive water in another season.

④ Introducing crop Rotation

Rotation of crop cultivation should be practiced. ~~If~~ Crops requiring more water should be followed by crop requiring less water and then by the crop requiring no water.

eg. Rice → wheat → cotton.

⑤ Optimum use of water.

Water should be used as per requirement. If more water is used it would ~~cro~~ raise the water table.

Improving Natural Drainage of Area. ⑨

Water on the land should not stay in one area. Continuous flow of water to be ensured. Natural flow of water is provided by bush and jungle cutting.

⑦ Economical use of water according to need

⑧ Sprinkler Irrigation Method.

It helps in maintaining the required amount of water to the plants. No extra amount of water is supplied. No ~~~~ infiltration losses from water courses.

Q(c) Explain the methods adopted to reclaim soils. (10)

All measures which are taken to prevent water logging also hold good for preventing salinity of lands.

Following methods could be adopted for reclamation of soils.

① Leaching

In this process the land is flooded with water so that alkaline salts get dissolved in water at They can be drained out by sub-surface terrains.

② Surface Drainage:

Excess water is removed using open ditches field drains land grading etc. Open ditches field drains which remove excess irrigation and storm water are broad and shallow are called shallow surface drains. Shallow surface drains carry run-off to point of entrance to outlet ditches.

③ Surface Inlets.

A surface inlet is a structure constructed to carry The pit water into sub-surface drain. The surface water from pot hole depressions may be removed by (a) Random field drain (B) Inlet Surface Inlet.

Sub-Surface Drainage

Surface drainage alone is seldom sufficient to remove excess water from the crop root zone. Deep ditches or sub-surface pipe drainage systems enable a more rapid water table draw down. The down stream ends of the laterals are normally connected to a collector drain. There are two types of sub-surface drainage ho (A) horizontal Drainage
(B) Vertical. Drainage

(A) Horizontal Drainage → are used in irrigated, arid and semi-arid regions to reclaim saline and water-logged lands, and to maintain favourable long term salt and water balances in the crop root zone.

(B) Vertical Drainage → By means of tubewells is also used to control water logging and salinity. The primary purposes of tubewell are the same as those of horizontal drains and at the same time to extract ground water for irrigation. As a result of pumping the water table is lowered and salinization due to capilarity is minimized.

Q No 3 (a) How does kennedys theory differ from lacey's theory for the design of irrigation canals.

Ans.

Difference between kennedys theory and lacey's theory

kennedys theory.	Lacey's theory.
→ Silt is kept in suspension by the vertical component of eddies. Kennedy assumed that silt is kept in suspension by eddies generated only at the bed and D is relevant parameter	→ Silt is kept in suspension by the vertical components of eddies. Lacey advocated that such eddies generated throughout the perimeter of the channel and considered the hydraulic radius R as the relevant parameter.
→ It recomended the use of Kutter's equation	→ It gave its own flow equation. mean velocity
→ Introduced critical velocity ratio (m) to account for silt grade	→ Introduced silt-factor and gave an equation for its determination from the avg particle size
→ Bed slope was selected on the basis of the available ground slope or is obtained from wood's normal table.	→ gave its own equation for bed Slope
→ Design of channel is not unique. It depends upon bed slope S and B/D ratio	→ Design is unique.
→ Tedious and involves trial & error method	→ Simple & straight forward.
→ Applicable to irrigation channels	→ Applied to natural channels.
→ It didn't give any such equation	→ Flow equation applicable to both regime and non-regime channels.

3)(b)

Design a regime channel for a discharge of 30 cumecs and mean diameter of the particle of 0.56 mm using Lacey's theory. (13)

Solution

Discharge $Q = 30$ cumecs.

Mean diameter of particle : $d_{mm} = 0.56mm$.

Assume side slope $= \frac{1}{2} : 1$

As

$$f = 1.76 * \sqrt{d_{mm}}$$

$$f = 1.76 * \sqrt{0.56} = 1.317$$

As

$$V = \left(\frac{Q * f^2}{140} \right)^{1/6}$$

$$V = \left(\frac{30 * (1.317)^2}{140} \right)^{1/6} = 0.848 m/s$$

and $A = Q/V = 30/0.8 = 35.38 m^2$.

Now

$$P = 4.75 * \sqrt{Q}$$

$$\Rightarrow P = 4.75 * \sqrt{30} = 26.02m$$

Regime Scour Depth $= R = 0.47 \left(Q/f \right)^{1/3}$

$$= 0.47 * \left(\frac{30}{1.517} \right) = 1.332m.$$

As

$$S = \frac{f^{5/2}}{3340 * Q^{1/6}} = \frac{(1.317)^{5/2}}{3340 * (30)^{1/6}} = 0.00034.$$

Now

$$A = BD + 0.5D^2$$

$$= 35.38 = BD + 0.5D^2 \longrightarrow (i)$$

also

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

$$26.02 = B + 2.24D \longrightarrow (ii)$$

After solving eq (i) & equation (ii)

$$\boxed{B = 22.66m} \quad \boxed{D = 1.5m} \quad \boxed{S = 0.00034}$$

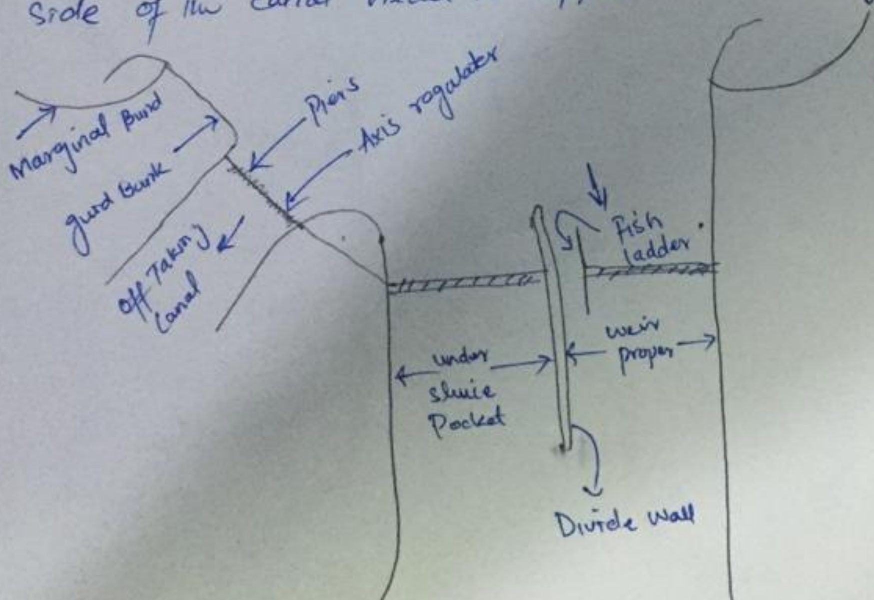
Q No(4) Write Notes on the following.

(1) Canal Head Regulator. (14)

A structure which is constructed at the head of the canal to regulate water flow of water is known as canal Head Regulator.

It consists of number of piers which divide the total width of the canal into a number of spans which are known as bays. The piers consist of number of tiers on which the adjustable gates are placed.

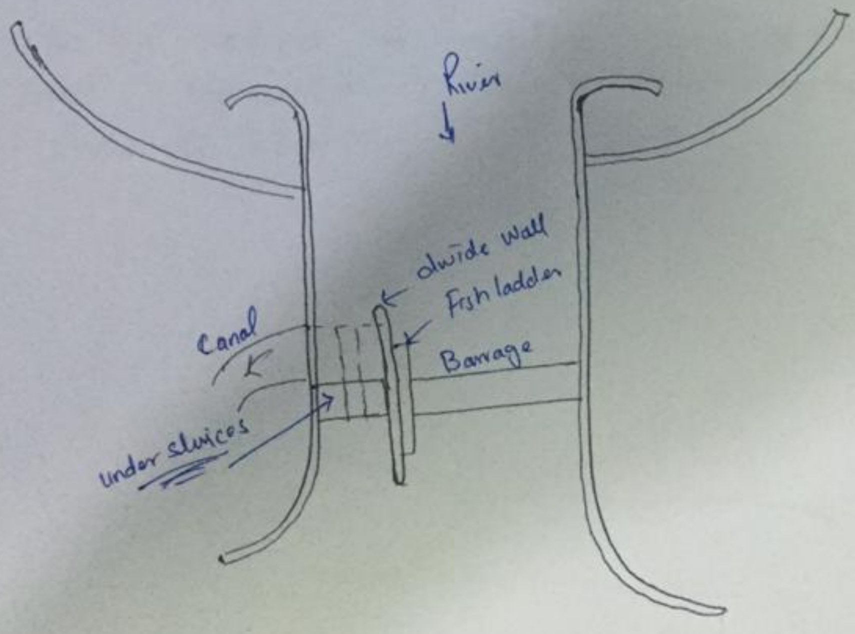
The gates are operated from the top by suitable mechanical device. For the facility of operating the gates a platform is provided at the top. Some piers are constructed on the down stream side of the canal head to support the roadway.



Under Sluices

These are the openings provided at the base of barrage. These openings are provided with adjustable gates. Generally, these gates are kept closed. The suspended silt continuously deposit infront of the canal head regulator.

When the silt is deposited upto certain considerable amount the gates are opened and the deposited silt is loosened with an agitator mounted on the boat. The water flows towards the downstream through scouring sluices. The gates are then closed, but during flooding the gates are kept opened.

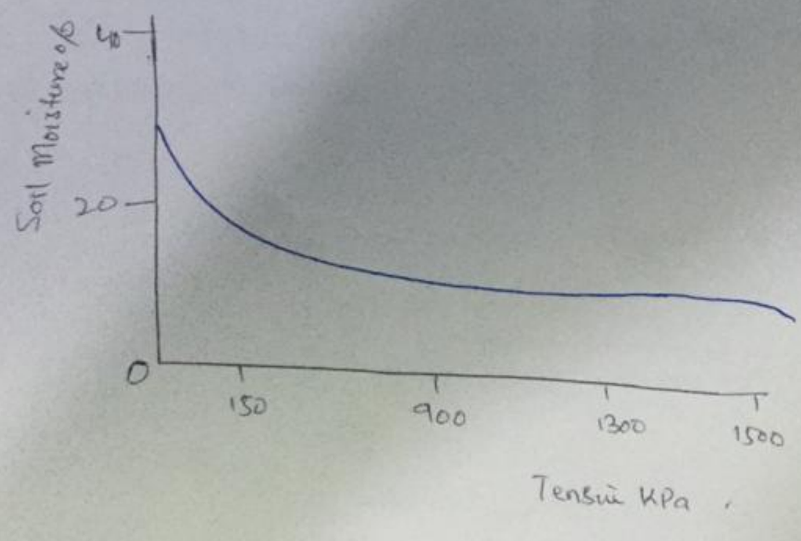


Permanent Wilting Point.

It is the when there is no water ~~are~~ available to the plant. The permanent wilting point depends upon the plant variety, but it is is usually around 1500 kPa. At this stage, the soil still contains some water, but it is difficult for the roots to extract from the soil. At this limit if no additional ~~paint~~ water is supplied most of the plants die.

The moisture content at the permanent wilting point varies with soil texture. The permanent wilting point corresponds to the inferior limit of available water.

In general, the permanent wilting pt is also determined in lab, by retention the curve method. In this method the moisture value of the wilting point is represented by the balance moisture with tension of 1.500 kPa.



Field Capacity:

After the rain or irrigation, the when all the gravity water is drained down to the water table, a certain amount of water is retained on the surfaces of soil grains by molecular attraction and by loose chemical bonds. This water cannot be easily drained under the action of gravity, and is called field capacity.

In other words, field capacity is thus water content of a soil after free drainage has taken place for a sufficient period.

The field capacity water consists of two parts.

① Attached to the soil molecules by surface tension against gravitational forces that can be extracted by plants by capillary action.

② Attached to soil molecules by loose chemical bonds. This water cannot be removed by capillarity called hygroscopic water.

Expressed as,

$$\text{Field Capacity} = \frac{\text{Wt of water retained in a certain Vol of soil}}{\text{wt. of the same volume of dry soil}} * 100$$