DIPLOMA EXAMINATION IN ENGINEERING/ TECHNOLOGY/MANAGEMENT/COMMERCIAL PRACTICE

Irrigation Engineering

PART –A

I. Answer all questions in one or two sentences. Each question carries 2 marks.

1) Mention the units of Duty and Delta

Unit of duty is Hectare/Cumec and Unit of Delta is mm or cm (1+1 mark)

2) List any two seepage and percolation control measures

Providing clay puddling, Cut off wall, Central impermeable core (Any two 1+1 mark))

3) Mention the two common types of head works

Diversion head work (Weir and Barrage) and Storage head works (Tanks and dams) (1+1 marks)

4) Give two examples each for rigid dam and non-rigid dam (1+1 marks)

Rigid dams – Masonry dam & Concrete Dam, Non-Rigid dam Earthen dam & Rock fill dam

5) State the classification of canal based on alignment (Any two 1+1 marks)

Ridge canal, Side slope canal and contour canal

II. Part –B Answer any Five questions – (Each question carry 6 marks)

1. State the importance and necessity of irrigation in India
   - India is an agrarian country with majority of people depending on agriculture for their livelihood.
   - India is a vast country with world's second largest population with limited cultivable area and has to produce more food grain from lesser cultivable area.
   - Due to peninsular nature, the climate and the available rainfall in the country is not uniform.
   - The distribution of rain fall is not uniform during various seasons of the year.
   - When one part of the country is reeling under floods other part is suffering from drought.
   - India is cultivating a wide variety of crops which requires different Delta. Cultivation is not fully depending on the effective available rainfall.
   - To generate more revenue from land, the lands need to be cultivated even during non-rainy seasons.
   - Due to the availability elevated high land there are suitable location for building dams for controlling floods and providing irrigation. Due to these reasons India needs irrigation projects. (Any 4X1.5)
2. What are the factors affecting runoff (Any six 6 X 1 marks)
   - Rain fall, its intensity and duration.
   - Slope of the terrain and shape of the catchment.
   - Permeability of the terrain
   - Vegetation cover
   - Ambient temperature
   - Relative humidity of atmosphere and wind velocity
   - Evaporation rate

3. Differentiate between storage head works and diversion head works with respect to their suitability.
Head works: Head works are hydraulic structures provided at the head of the canal (Starting location) in order to draw water from the source to the canal. Head works can be classified as storage head works and diversion head works. Example for storage head works are Dams and Tanks. Weir and Barrage are examples of diversion head works. In storage head works the water is collected and stored by constructing a dam or a tank to form storage of water called reservoir. In the case of dams separate canal regulator is constructed on the right bank and the left bank of the dam to take water to canal. A tank sluice is provided in the body of the tank to takeout water from a tank. Factors of suitability of storage head works: Storage head works are constructed where there is a scope for economically constructing a dam. A deep and narrow gorge surrounded by mountains is an ideal location for constructing a dam. Other factors are catchment area and its characteristics, rainfall, permeability of soil, nature of foundation soil, area of forest submergence, convenience for aligning canal, capacity available for the reservoir, seismic conditions of the area etc. Suitable site for a diversion head works: The diversion head work is constructed in the straight portion of the river free from meandering. The banks of the river should be firm and high to avoid flooding. It should be convenient to align the off taking canal. The bed of the river should have an impermeable foundation. If a bridge is also constructed along with a diversion head works, the convenience for aligning the approach road should be considered. (3+3=6 marks)

4. List different types of dams and mention their suitability. (Any Six 6 X 1 = 6marks)

Dam is a hydraulic structure constructed for impounding water. Usually dams are constructed bridging deep and narrow gorge across mountain ranges mostly with masonry or concrete. Dams can be classified on different basis. Based on materials used they are classified as stone masonry dam, concrete dam, earthen dam, rock fill dam steel dam (Coffer dam), and wooden dam. Based on the basis of withstanding hydrostatic pressure dams are classified at gravity dam, arch dam, and buttress dam. Based on the height dams are classified as low dam (below 88m) and high dam (above 88m). Based on the purpose they are classified as flood control dams, drinking water projects, hydroelectric projects, irrigation projects and multi-purpose dams. Construction of arch demands strong abutments and narrow gorge. Masonry dams and rock fill dams require good quality of rock required for the stones. The maximum permissible masonry dam is limited. Earthen dams require large quantity of soil with very low permeability. In this case also height is limited. Both earthen dams and rock fill dams are flexible dams which can withstand more deformation than other types of dams. Concrete dams are versatile and can be used effectively for high dams. The availability of raw material demands good quality rocks. This type of dam is also costly. Steel dams are usually used for cofferdams. Wooden dams are used for making small reservoir in forest area, where wood is available in plenty and there is scarcity for other materials.

5. Differentiate between FRL and MWL of a reservoir **(Figure Not compulsory)** (3 + 3 = 6marks)

Full Reservoir Level (FRL): It is the level corresponding to the storage which includes both inactive and active storages and also the flood storage, if provided for. In fact, this is the highest reservoir level that can be maintained without spillway discharge or without passing water downstream through sluice ways.
Maximum Water Level (MWL): This id the water level that is ever likely to be attained during the passage of the design flood. It depends upon the specified initial reservoir level and the spillway gate operation rule. This level is also called sometimes as the **Highest Reservoir Level** or the **Highest Flood Level**.

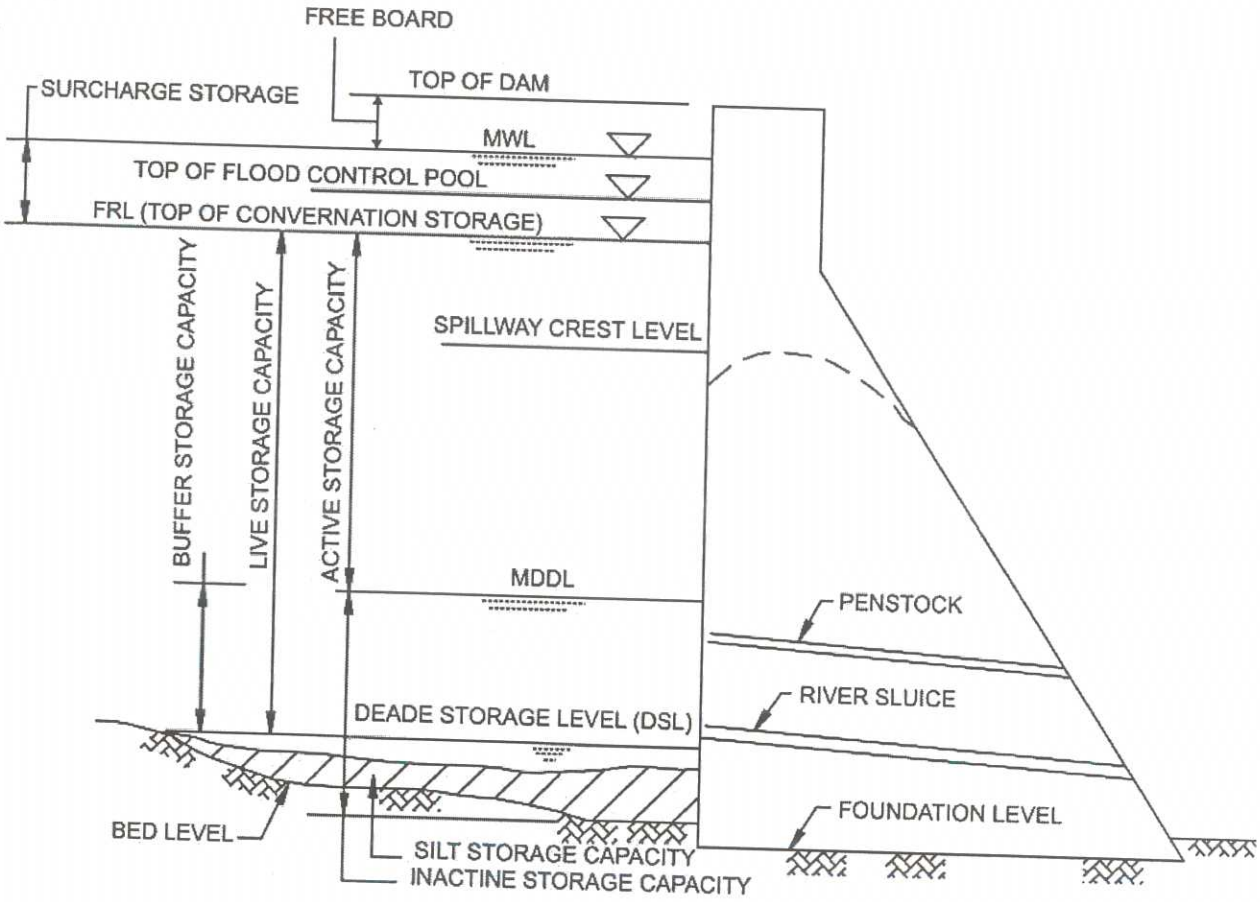
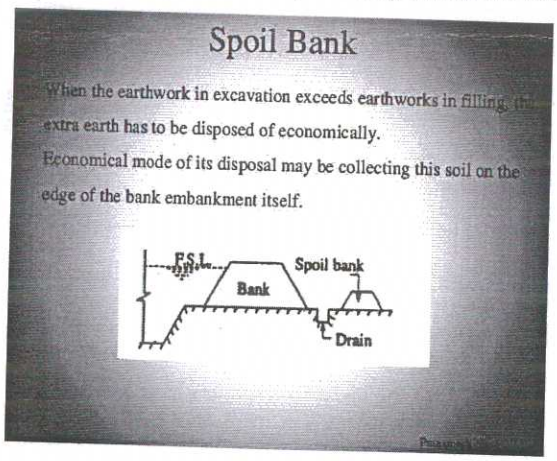
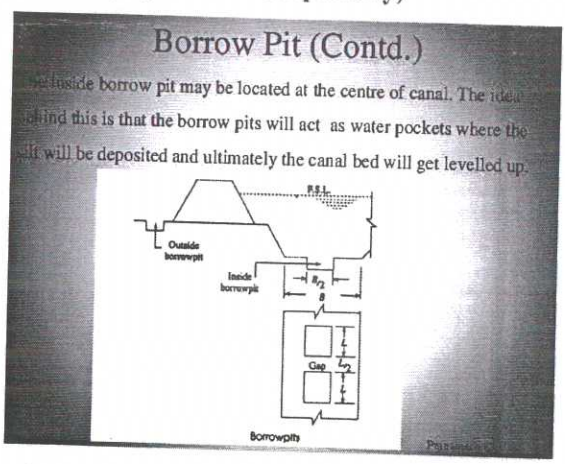


FIGURE 1. SCHEMATIC DIAGRAM SHOWING STORAGE ZONES (OF CAPACITY) NOMENCLATURE

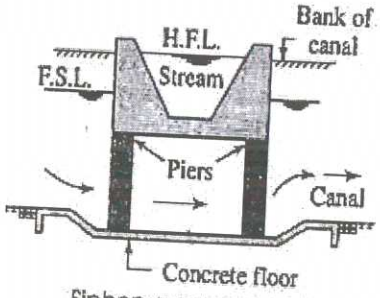
6. Explain the terms borrow pit and spoil bank with their purpose. **(Figure not compulsory)**





In the case of canal construction and road formation the earth work involves both cutting and filling. In certain cases filling may be more than cutting. In such cases in order to find out more soil for filling; rather than bringing soil from outside, additional soil is procured by digging rectangular pit in the bed of the canal with depth not exceeding 50cm. Such pits are called borrow pit and these pits will be filled in due course by silting. Similarly if there is excess soil obtained from cutting, it will be stored as trapezoidal stack on the banks of the canal as departmental soil. Such stacks are called spoil bank. (3 + 3 = 6 marks)

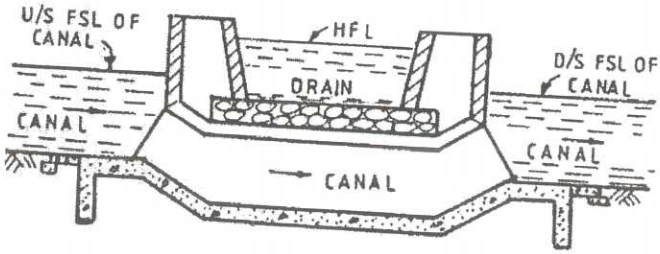
7. Differentiate between syphon aqueduct and canal syphon (siphon super passage). **Figure not compulsory**

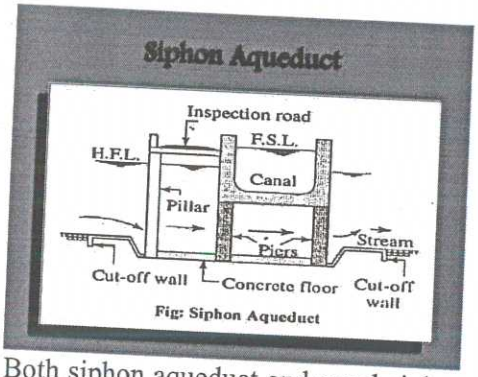


Siphon super passage

Or Canal Syphon

OR





Both siphon aqueduct and canal siphon are cross drainage works constructed when a canal crosses a natural drain. If the HFL of the natural drain is above the bed level of the canal but below the FSL, the type of CD work is known as siphon aqueduct. On the other hand if the FSL of the canal is above the bed level of the natural drain but below its HFL, the type of CD work constructed is known as siphon super passage or canal siphon. (3+3=6 marks).

PART C

(Answer one full question from each unit. Each full question carries 15 marks)

Module - I

III a) Differentiate between (a) Perennial and inundation irrigation (b) Flow and lift irrigation (c) Storage and direct irrigation and mention the situation at which these systems are adopted. (2+2+2+ 2 marks for situation)

In Perennial irrigation system the irrigation water is applied to the crop throughout the crop period on a regular basis throughout the crop period on regular need basis. Eg. Garden crops. In the case of inundation irrigation the entire area cultivated is flooded according to the water requirement of crop and this flooded water is used for its maturity. Only occasional supplementing is required. Eg. Paddy. Flow irrigation is performed through open channel like canals from head works and flows due to the bed slope of the canal. Here the source of water is at a higher level than the command area. In certain cases the source of water may be ground water source like well, pond or river which may be situated at a lower level than the command area; hence water is required to lift using a mechanical means like water pump, such an irrigation system is called lift irrigation. Storage irrigation and diversion irrigation are two types of head works. Water is stored in a reservoir or tank by constructing a dam or a bund and this stored water is discharged to the canals for irrigation through the head works. In the case of diversion irrigation; instead of storing water; water is directly diverted to the canal by heading up of water constructing a weir or barrage. Diversion irrigation is feasible if the river is of perennial nature and sufficient quantity of water is available for irrigation.

III b) Explain Duty, Delta and drive a relationship between them. (2+2+3=7marks)

Duty is the measure of irrigation capability of an irrigation project. It is expressed as the area of land that can be irrigated (usually expressed in hectare) by discharging a unit quantity of irrigation water (Cumec ie. Cubic meter per second). Thus the unit of duty is hectare/Cumec). Duty mainly depends on water requirement of crops, permeability of soil, climatic conditions and other losses.

Delta is the water requirement of crops expressed as depth of water with respect to the area of cultivation. Delta is expressed in mm or cm of water. Among many other factors duty mainly depends on type of crop, its water requirement and available effective rain fall.

OR

IV a) Explain how the discharge through a river is measured. (4 marks for area and 4 marks for velocity measuring)

For measuring the discharge we have to understand the velocity and the area of cross section of flow. Q=A X V. The area of cross section is measured either by taking soundings at regular interval across the river or by constructing a trapezoidal or rectangular weir. The depth of flow is measured using river gauge, thus the area of cross section of flowing area is calculated. The velocity of flow can be measured by any of the following methods such as surface float, Velocity rod, and Pitot tube. While using surface float and velocity rod, velocity of flow is measured by measuring the time taken by the float for flowing between two points marked on the banks at a fixed distance apart (usually 100m) using a stop watch. In the case of using current meter, the velocity of flow can be directly measured. Using the Pitot tube the rise in water level in the Pitot tube is measured and the velocity of flow is calculated.

IV b) Write short notes on Crop period, Base Period and Kore watering & its purpose. (7marks)

Crop period is the period between sawing the seedling and harvesting the crop. It depends on the type and variety of the crop. The hybrid high yield variety of crops developed have shorter crop period. (2marks)

Base period is the period for which irrigation is applied to the crops. It is the period between first watering and last watering done to a crop. Even though the duration of crop period and base period are the same, the period may be slightly overlapping. (2marks)

Kore watering is the irrigation to be prior to sawing of seed or planting of the crop. This is done for preparing the land for cultivation such as watering for ploughing digging etc. (2+1=3 Marks)

Module – II

V a) Sketch the general layout of weir, mark the parts and explain the function of each component. (4+4=8 marks)

Parts of a weir: Weir is a masonry barrier constructed across a river to raise the water level in the upstream side of the river for conveniently raising the water level. The major parts of a weir are 1) Weir proper 2) Under sluice portion 3) Divide wall 4) Fish ladder 5) Under sluice 6) Canal regulator 7) Guide banks and 8) Marginal bunds

Weir proper is the main portion of the weir which will be devided in to bays by the piers. The piers will be provided with slots for inserting pannels to futher raising the water level if necessory. The devide wall devides the weir proper portion and the under sluice portion. It extends to some length in the upstream and down stream side. Fish ladder is mounted along the side of the devide wall. The devide wall avoids the turbulance at the mouth of the off taking canal. The under sluice portion will be at a lower level than the normal weir portion to divert more water near to the location of off taking cannal located by the side of the under sluice portion. The under sluice portion has got pockets to collect the silt which will be ejected to the down stream of the river during monsoon by opening the sluice valve. Weir is a barrier which obstructs the movement of fish and other aquatic creatures. Inorder to ensure the free

movement of migratory fish; fish ladder is provided by the side of the devide wall provided with baffle walls. The main function of the baffle wall is to regulate the velocity of flow. The maximum permissible velocity which enables the movement of fish against the flow is 4.5 m/Sec. The flow to the off taking canal is regulated by the canal head regulator. The weir is bult across the guide banks on either side. Guide banks anchor the weir to the banks. They aslo guide the flow from the wider river to the weir. Marginal bunds or the flood banks are the earthen bunds built on the upstream side to certain distance along the upstream side to accommodate more water and prevent the flooding of banks when the water level in the upstream side raises due to the construction of weir.

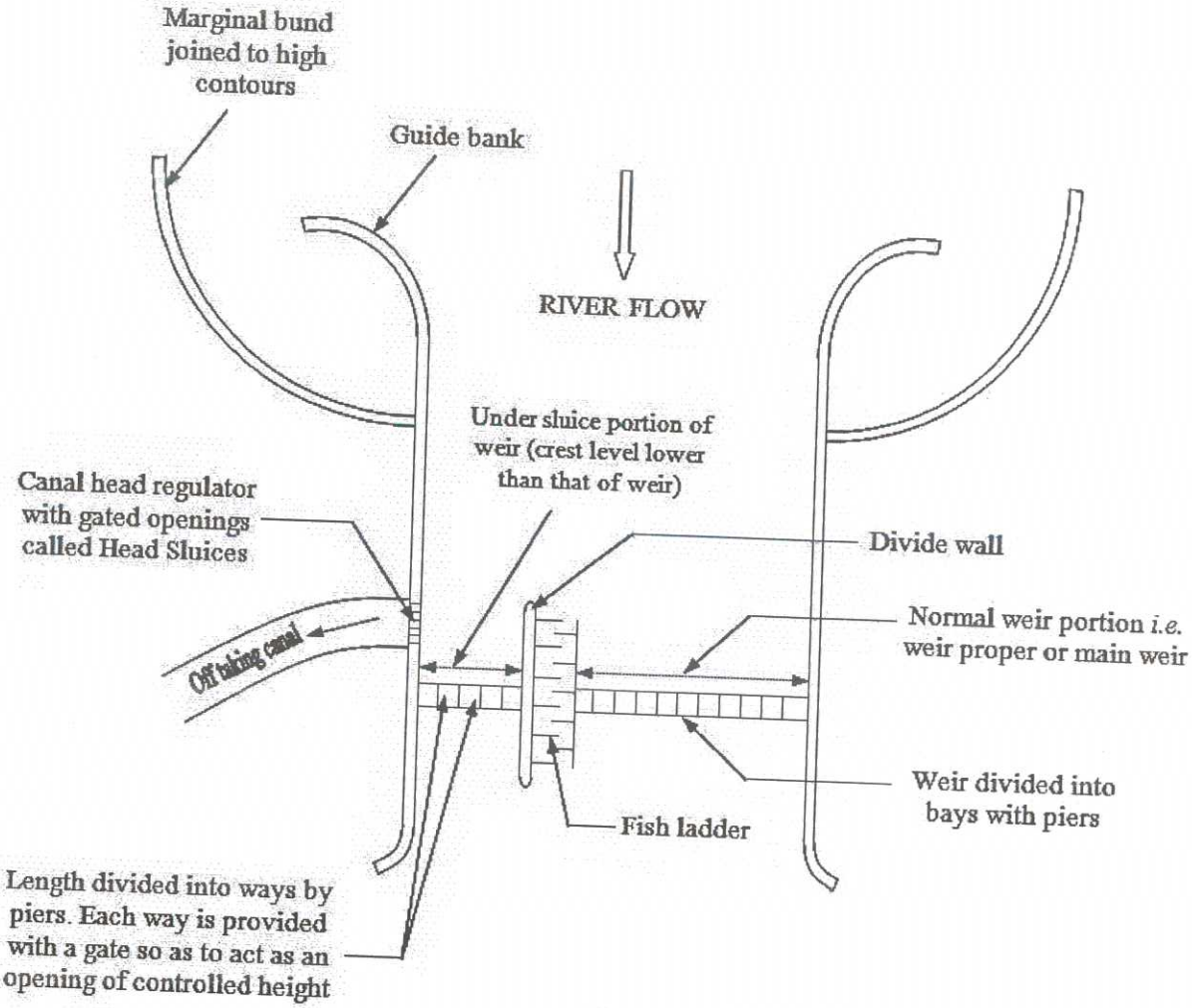


Fig: Typical layout of diversion head-works

V b) What are the factors to be considered while selecting a site for a diversion head works? (7 marks)

- The banks should be high to avoid flooding.
- There should be good foundation at site.
- Percolation through the bed should be minimum.
- The site should be at a straight reach of the river.
- The location should be free from meandering.
- The scouring and silting should be minimum.
- There should be convenience for off taking canal
- Maximum command area should be feasible.
- Necessity for a bridge along with the diversion head work should be taken in to consideration.
- Overall economy and environmental factors. (Any 7 x 1 = 7 marks)

OR

VI a) Discuss the effect of seepage and percolation in hydraulic structures and explain how it is controlled. (8 marks)

The major effects of seepage are the following. (Any 4=4marks)

- Failure of the structure by uplift and overturning.
- Loss of water through the bed and body of the structure.
- Scouring and silting
- Lowering the durability of the structure.
- Sloughing of the toe and sudden failure in the case of earthen dams

Remedial measures are the following (Any four=4 marks)

- Proper compaction of soil in the case of earthen dams.
- Provide impermeable central core in the case of earthen dams and rock fill dams.
- Provide drainage gallery in concrete and masonry dams.
- Provide clay puddling in the upstream bed level.
- Provide cut off wall in the foundation
- Provide pitching in the U/S and revetment in the D/S.

VI b) Distinguish between barrage and weir with situation each is preferred. (3+3+1=7 marks)

Both weir and barrage is diversion head works. **Weir** is a masonry barrier constructed across a river to a height of 1.5 to 2m in order to raise the water level in the upstream side of the river for conveniently taking water to off taking canal. Weir proper is the main portion of the weir which will be devided in to bays by the piers. The piers will be provided with slots for inserting pannels to futher raising the water level if necessory. Fish ladder is mounted along the side of the devide wall inorder to ensure the free movement of migratory fish. Weir is also used to measure the dicharge through the river.

Barrage: The Barrage is also a diversion head work. The function of the barrage is similar to that of weir. The major difference is that in the case of barrage only a sill will be constructed with masonry and the major raising of water level is achieved using regulator gates. Since the sill level is near to the bed level no separate fish ladder will be provided. Among many regulators a few will be always kept opened to ensure minimum flow in the river and also facilitate movement of fish. The location of barrage is so decided such that a bridge can be built conveniently atop the barrage connecting both the banks, this is usually termed as regulator cum bridge.

Module – III

VII) a) What are the major causes of failure of earthen dams (8marks)

The causes of failure of earthen dams can be classified in to three categories.

1. Hydraulic failure 2. Seepage failure and 3.Structural failure. (2marks)

The major modes of hydraulic failure are the following. (2marks)

By over topping – Erosion of upstream face – Erosion of downstream side by gully formation – Cracking by frost action – Erosion of downstream toe.

Seepage failure is attributed by the following reasons. (2 marks)

Piping through the foundation – Piping through the body of the dam – Sloughing of the downstream toe.

The major causes of Structural failures are foundation slide and slide in embankment. (2 marks)

VII b) Sketch the cross section of a tower head type tank sluice. Mark the parts and mention functions. (7marks)

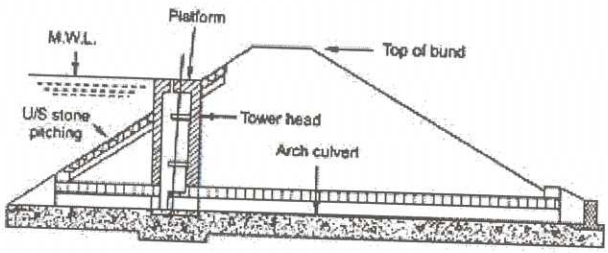
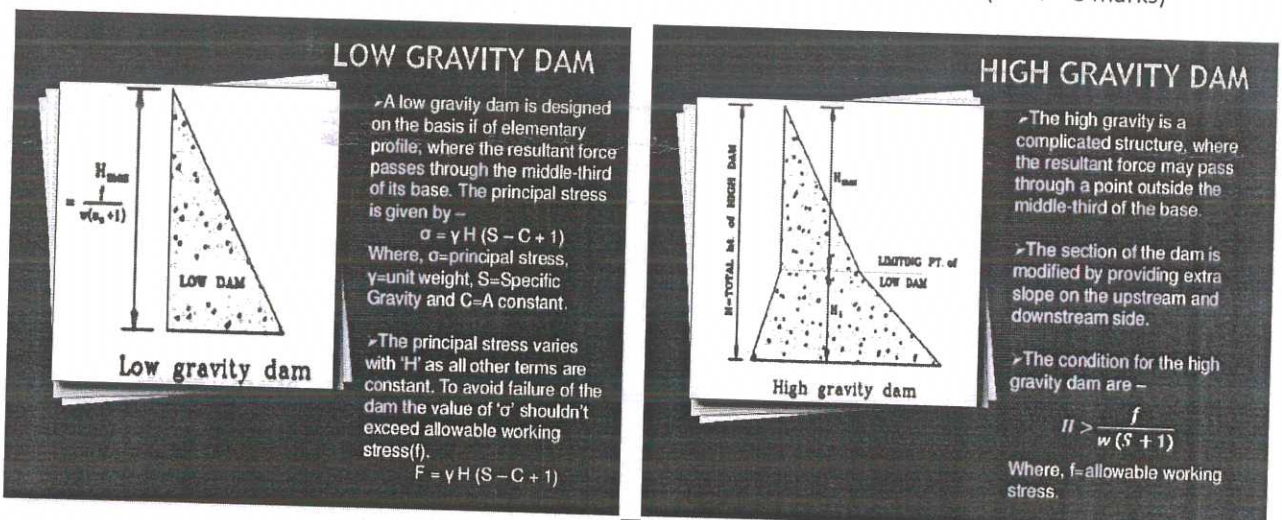


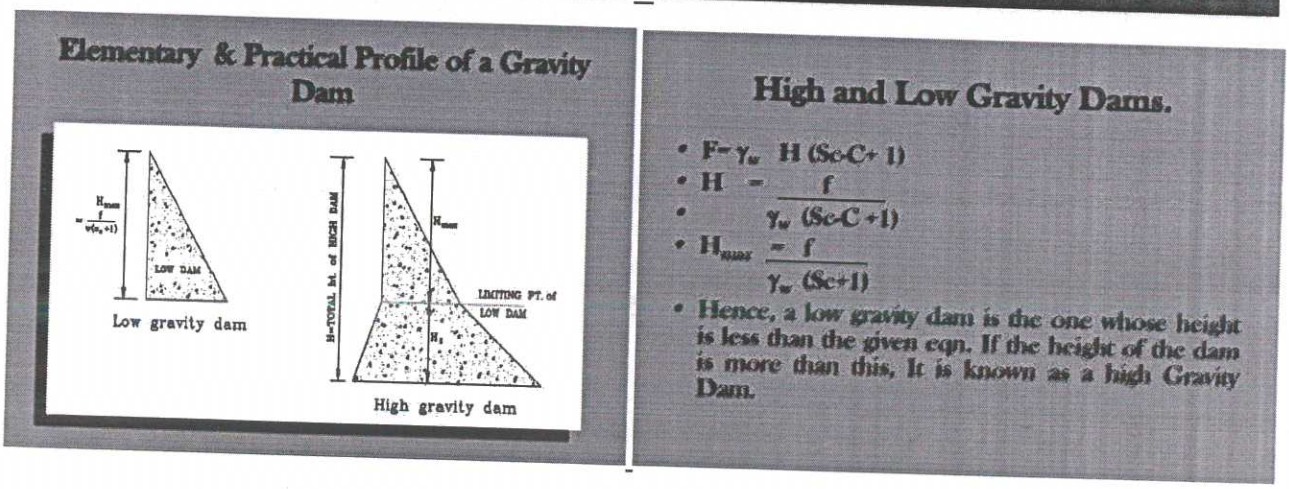
Fig. 10.12 Tank sluice with tower head.

The major parts of a tank sluice are the earthen bund, tower head, sluice shaft, sluice valve, barrel pipe or rectangular chamber, inlet and outlet chambers, erosion and seepage control measures such as pitching and revetment. The earthen bund facilitates the storing of water in the tank, the tower head is the masonry structure in the upstream side erected above the MWL to house the sluice valve, sluice shat facilitates the installation of sluice regulating gear, and sluice valve controls the discharge to the canal. Barrel pipe or rectangular masonry duct is placed across the bund in order to facilitate the discharge of water from reservoir to the canal. The inlet and outlet chambers stream line the flow. The revetment and pitching control the erosion and seepage. (4marks + 3 marks for sketch)

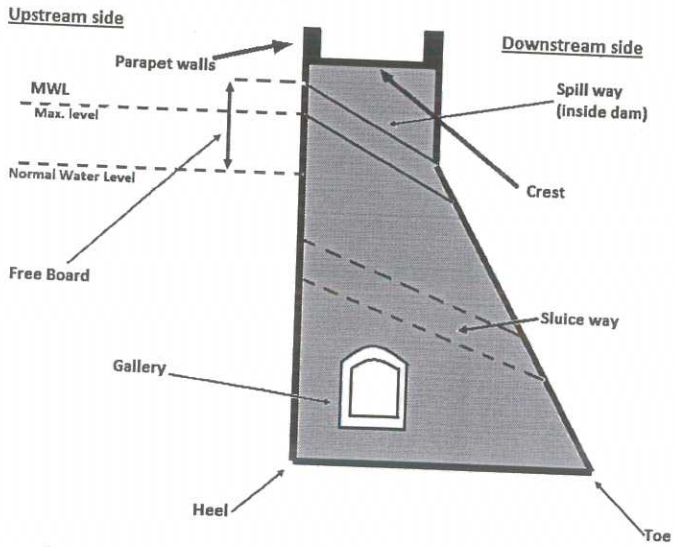
OR

VIII a) Distinguish between low and high dams with their profile sketches. (4 + 4 = 8 marks)





Profile Shape of a low dam



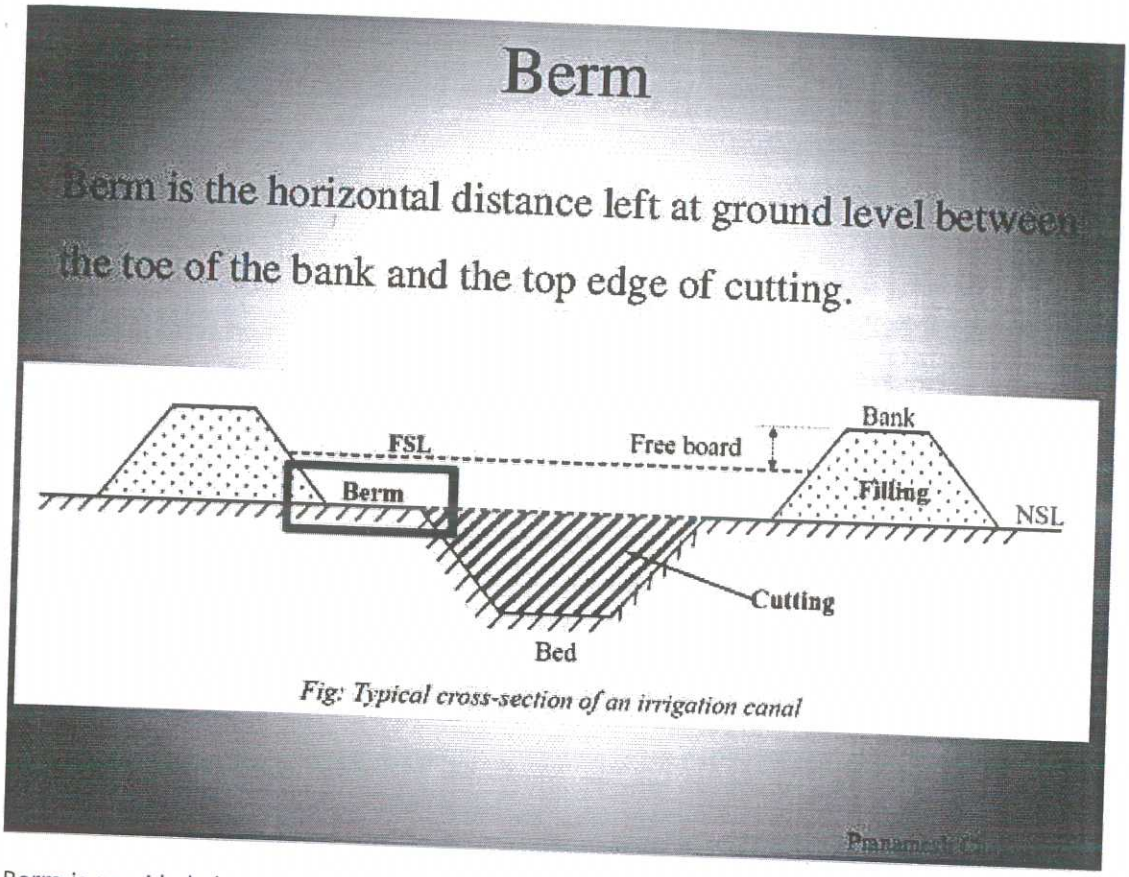
VIII b) Discuss the uses of surplus weir and flush escape with their suitable locations. (7 marks)

Both the surplus weir and flush escape are used to discharge or spill off the surplus water from a tank or a canal when the water level in the tank or canal exceeds the specified level (FSL in the case of canal and FTL or FRL in the case of a dam). Weir is provided as a stepping rectangular notch made of masonry in the body of a canal or weir, this act like a canal fall. Surplus escape is also made of masonry or concrete within the bund of a tank or weir, similar to the shape of an ogee spill way. (4 marks)

Both these structures are constructed within the body of the earthen bund of the canal or tank. The location is selected in such a way to facilitate the discharge of surplus water safely and conveniently to a natural drain. A rocky or impermeable bed for the foundation of the structure is preferred. The downstream should be free from soil erosion. The downstream level should be high in order to minimise the height of fall and turbulence. (3 marks)

Module – IV

IX a) Draw the cross section of canal in partially cutting and filling and explain the function of berm. (8 marks)



Berm is provided along the inside slope of a canal wherever there is a change in side slope (between cutting and filling). It will control the slipping of the soil fill alongside slope. It will also serve as a protective measure in the event of fall of persons or animals by accident.

IX b) What are the function of canal sluice, canal drop and spill ways & list types of spill ways? (7 marks)

Canal sluice is provided at the head works to regulate the flow to the canal from the reservoir or a river. (1mark)

When canal is aligned along a terrain with steep gradient, it is not feasible to provide bed slope at such a steep gradient since it is likely to cause erosion; otherwise it may lead to excessive cutting or filling. Under such a situation normal bed slope is provided for certain length and thereafter a sudden fall is provided to the bed level by constructing a masonry structure called canal fall or canal drop. Canal drop is also provided at location where the ground level abruptly falls. (3 marks).

Spill way is an arrangement provided in an overflowing type of dam to spill off the excess water in the reservoir, when the water level exceeds the permissible level. They can be considered as the safety valve of dams in order to maintain the water level in the reservoir at permissible level. The common types of spillways are Ogee spillway, Chute spillway, side channel spillway and Siphon spillway. (3marks)

OR

X a) List any four cases of cross drainage work and explain each case. (8marks)

Different cases of Cross drainage work.

Aqueduct: Bed level of canal well above the HFL of the natural stream.

Siphon aqueduct: HFL of the drain above the bed level of the canal but below the FSL of the canal

Super passage: Bed level of the natural drain well above the FSL of the canal

Siphon supper passage or Canal siphon: FSL of the Canal above the bed level of the natural drain but below the HFL of the natural drain.

Under Tunnel: It is U shaped duct constructed when a canal crosses a road or railway. There will be two well like structures on either side of the road connected by a pipe or channel underneath the road.

Level crossing: This arrangement is provided when a canal crosses a natural drain with the bed level of the both crossing almost at the same level. There will be regulators in the downstream side of the junction; for both the canal and the natural drain in order to regulate the flow level. Water from both the sources will be allowed to mix.

Inlet-Outlet: The situation is similar to level crossing with regard to the bed level; but the discharge in the natural drain will be nominal, it will supplement the irrigation water. The excess water above FSL will be spilled off to another natural drain source at convenient location in the down reaches of the canal. (Any 4 X 2 = 8 marks)

X b) Discuss the causes and remedial measures of soil erosion. (7 marks)

The major causes of soil erosion are the following. (Any 6 X 0.5 = 3 marks)

- Flood and runoff at steep terrain.
- Land slide
- De-forestation
- Un-scientific agricultural practices
- Wind
- Over grazing
- Quarrying and Mining
- Meandering of rivers.
- Sea-erosion

The preventive measures are the following. (Any 8 X 0.5 =4 marks)

- Afforestation
- Contour bunding.
- Gully Plugging
- Construction of retaining wall
- Gabion construction
- Use of Geo-Textiles
- Turfing
- Pitching
- Control the herbivores population
- River training works
- Anti – Sea erosion works
- Check un-scientific quarrying and mining operation.