UNIT 4 WEIRS AND BARRAGES

Structure

4.1 INTRODUCTION

In this unit you will learn about structures that are constructed across rivers to divert the flow in the river into offtaking channels for the purpose of irrigation. An irrigation canal takes its supplies from a stream or river. To divert the water into the canal, it is necessary to construct structures across the river and at the head of the offtaking channel. These works are termed as "Headworks". The structures constructed at the head of the canal is termed as "Canal Head Regulator" and its purpose is to control the supplies of water and entry of silt into the offtaking canal.

Objectives

At the end of this unit, you should be able to

- describe a weir and a barrage,
- classify weirs,
- discuss the factors to be considered in selecting the site for a weir or a barrage,
- sketch the layout of a headworks,
- compare a weir with a barrage, and
- discuss the features of a headworks.

4.2 WEIRS

The weir provides the obstruction across the river required to raise up its water level and divert the water into the canal. It is aligned at right angles to the direction of flow in the river.

4.3 CLASSIFICATION OF WEIRS

There are three main types of weirs:

1) Masonry weir with vertical drop,
2) Rockfill weir with sloping apron, and
3) Concrete weir with sloping glacis downstream.

4.3.1 Masonry Weir with Vertical Drop

Figure 4.1 shows a typical cross-section of a vertical drop weir of masonry. This weir consists of a horizontal floor and a masonry crest with vertical or nearly vertical downstream face. The floor design was usually on Bligh's theory for weirs of this type. Part of the raising up of water level is usually carried out by shutters at the top of the crest which may be dropped down during a flood so that the afflux may be reduced. The drowned weir formula, though not very accurate, may be used for calculation of discharge.

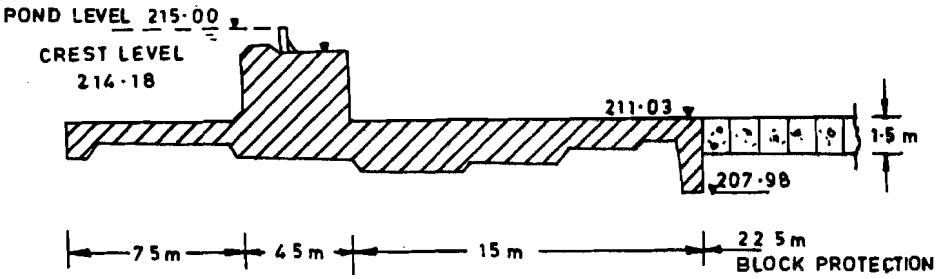

Figure 4.1 : Masonry Weir

7.3.2 Rockfill Weir with Sloping Apron

Figure 4.2 shows the cross-section of a rockfill weir. In this type, the boulders are laid in the form of a glacis on the upstream and downstream with a few intervening walls. The downstream slope is generally made very flat. It is the simplest type of construction and many such works are ancient. Their stability or principles of design are not susceptible to any theoretical treatment.

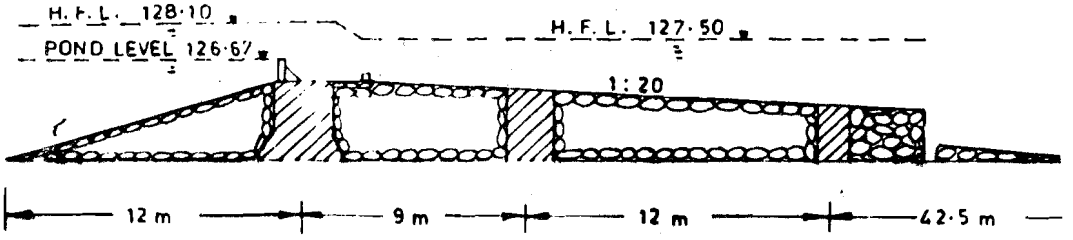

Figure 4.2 : Rockfill Weir

This type of weir requires a very large quantity of stone, both at the time of initial construction and during subsequent maintenance. Its use is, therefore, restricted to places where stone and unskilled labour are available in abundance.

4.3.3 Concrete Weir with Sloping Glacis Downstream

Weirs of this type are of recent origin and their design is based on modern concept of sub-surface flow based on Khosla's theory. A typical cross-section of this type is shown in Figure 4.3. Sheet piles of sufficient depths are driven at the ends of upstream and downstream floor. Sometimes an intermediate pile line is also provided. The hydraulic jump is formed on the glacis to dissipate the energy of overflowing water. Weirs are now being constructed exclusively of this type.

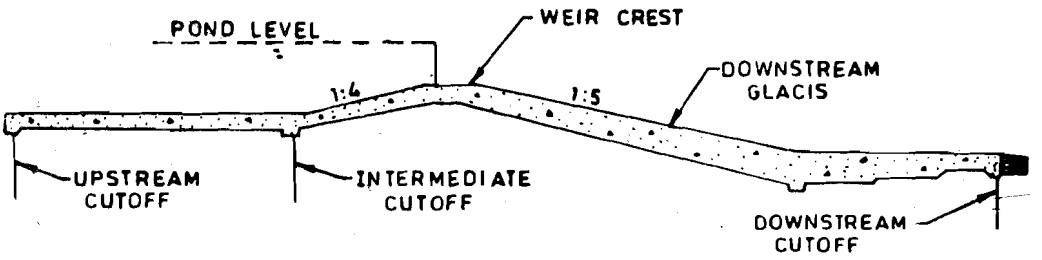

Figure 4.3 : Concrete Weir

SAQ 1

How are weirs classified?

4.4 BARRAGES

In case of barrages the crest is kept at a low level and the ponding up of the river for diversion is accomplished primarily by means of gates. These gates can be raised clear off the high flood level and thus enable the high flood to be passed with a minimum afflux. By suitable manipulation of the gates, the flow condition above the barrage can be closely controlled and shoal formation or cross currents upstream of the work minimised. A barrage provides maximum control on the river but is comparatively more costly.

Figure 4.4 shows a cross-section through a barrage. In this particular case there is no raised crest at all, but that is not a necessary pre-requisite of a barrage. The difference between a barrage and a weir is only qualitative. In the former the gates or shutters provide the larger part of the ponding, while in the latter the solid crest carries out most of the raising of water level or ponding and the top shutters are relatively small in height.

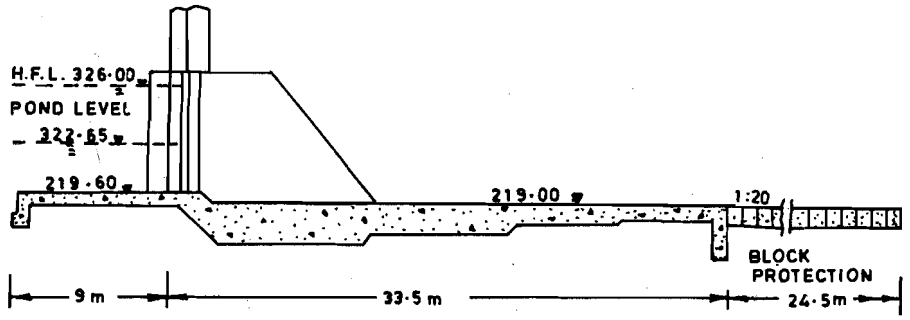

Figure 4.4 : Cross-section through a Barrage

SAQ 2

(i) What is a barrage?

(ii) How does a weir help in raising the water level or pond level?

4.5 SITE SELECTION

The selection of the site for a weir or a barrage should be made according to the following considerations:

1) A narrow, straight, well defined channel confined between banks not submerged by the highest flood should be selected as far as possible,

2) It should be possible to obtain a canal alignment capable of attaining command of its area with the necessary slope by moderate digging,

3) Availability of construction material within reasonable distance. This affects the cost of the work, e.g. absence of suitable soil for burning bricks within a reasonable distance may lead to an appreciable increase in the construction costs, and

4) Accessibility of the site and the expenditure required to connect it by rail or road, the healthiness of the climate of the site and availability of suitable location for providing a colony for workers on the project are other factors which may influence the choice. Defects in these respects can however be easily rectified by spending a little additional money.

SAQ 3

What are the considerations for selecting the site for a headworks?

4.6 LAYOUT

A typical diversion headworks consists of the following components:

a) • weir or barrage divided into bays by piers,

b) undersluices or scouring sluices,

c) divide wall or groyne,

d) fish ladder,

e) canal head regulator, and

f) river training works.

Figure 4.5 shows a typical layout of a canal headworks with all the components and including river training works.

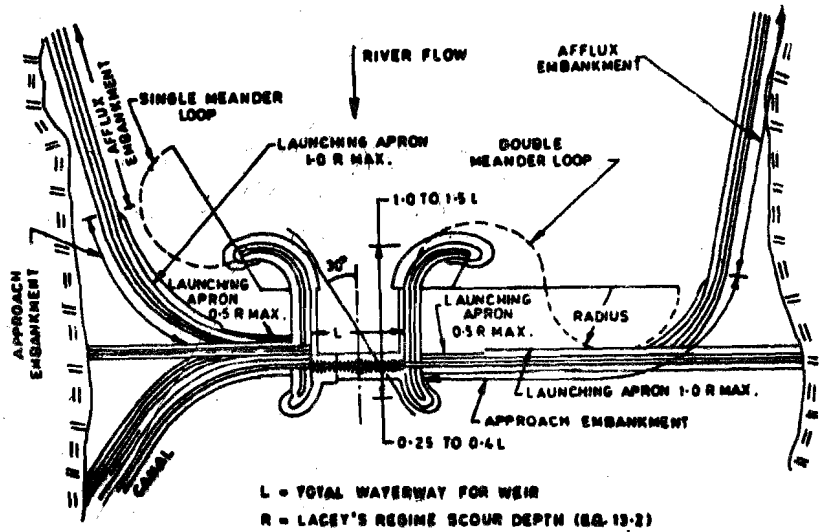

Figure 4.5 : Typical Layout of Canal Headworks Including River Training Works

SAQ 4

What are the components of a diversion headworks?

4.7 COMPARISON BETWEEN WEIRS AND BARRAGES

A weir is an ungated structure while a barrage has vertical lift gates. The weir crest is a masonry or concrete structure while in a barrage the crest is made of concrete. Barrages offer better control on the river outflow as well as the discharge in the offtaking canal than a weir. Because of the lower crest level of the barrage, the afflux during floods is small compared to weirs. A roadway across the river can be provided in a barrage while it not possible in a weir. The operation of shutters in the case of weirs is risky while the operation of barrage gates is free from such danger. Weirs are not provided with silt exclusion devices while barrages are provided with silt excluders.

SAQ 5

Compare the various features of a weir and a barrage.

4.8 HEADWORKS

Canal headworks may be divided into two classes:

a) Diversion works, and

b) Storage works.

Diversion works mainly serve to divert the required supply from the river into the canal. Their functions are :

1) To raise the water level in the river to the required extent for diverting the supplies into the canal and totally cut off all flow downstream of the works when the entire supply is required in the canal,

2) To regulate the intake of water into the canal and control silt entry, and

3) To reduce expensive cutting in the head reaches of the canal and facilitate command of the area by flow.

Storage works in addition to diversion, store surplus water when available in the river in excess of demand and supplement the direct flow of a river during keen demand.

4.8.1 Layout of Headworks

A river has four stages where a headworks could be located. They are:

a) **Rocky Stage** : In this stage, the river is in the hills. The bed slopes and velocities are high. The cross-section of the river is made up of rock or very large boulders.

b) **Boulder Stage** : The slope and velocity get reduced as the river emerges from the hills. Boulder and gravel form the bed and sides of the river. The river cross-section is usually well defined and confined between non-submersible banks on either side which are close to the main current of the river. Due to the high permeability of the foundation material, there is a strong subsoil flow in the boulder region.

c) **Trough Stage** : The river after passing through the boulder stage passes on to the alluvial plain created by itself. Alluvial sand silt form the river cross-section. The bed slope and velocities of flow are mild. During high floods the river spreads out over a wide area as banks higher than the high flood level are relatively far away from the main current of the river.

d) **Delta Stage** : As the river approaches the sea, the country slope and velocity fall down so much that the water is unable to carry its sediment load. The sediment is deposited and the river divides itself into a number of channels on either side of the deposit resulting in a delta.

For locating headworks, the first and last stages are unsuitable. The rocky stage presents no difficulty in constructing them. But it will be prohibitively costly to construct the channel leading water from the headworks to its command area. In the delta stage, the area available is small and irrigation requirements are not significant.

The choice actually lies between the boulder and trough stages. If the situation and level of the command area is such that the canal may be taken out either in the boulder stage or the trough stage without excluding any important part of the area from the command, a choice has to be made on the merits in each case.

The advantages of the headworks in the boulder and trough stages are :

1) These areas can grow good cash crops like transplanted rice, tobacco and sugarcane with irrigation.

2) Due to availability of stones and high banks, the initial cost of headworks in the boulder stage is smaller than in the trough stage.

3) In a boulder reach, river water can be diverted into the canal by means of a temporary boulder bund which is very cheap.

4) The falls available on the canal taken out in the boulder reach may be utilised for generation of hydroelectric power.

The disadvantages of the headworks in the boulder and trough stages are:

1) In the boulder region, there is a strong subsoil flow in the river bed, which appears on the surface in the trough stage. During lean periods, this means loss of a considerable percentage of the total river discharge.

2) With headworks in the boulder stage, the canal has to run in a tract with sand and boulder formation upto a great depth below the surface for some distance. Thus there are heavy seepage losses in this reach.

3) Many cross drainage works would be required on a canal taking off in the boulder stage.

4) As the areas near the hills are usually damp, the demand for irrigation in the head reaches of a canal taking off in the boulder region is likely to be slack.

SAQ 6

i) What are headworks?

ii) Describe the two types of canal headworks?

iii) What are the various stages of a river where headworks may or may not be located?

iv) What are the advantages and disadvantages of locating headworks in a boulder or a trough stage?

4.9 SUMMARY

In order to select and provide suitable headworks on any river, it is necessary to understand the difference between weirs and barrages. The different types of weirs are classified depending upon the materials used. The factors to be considered in the selection of a suitable site for weirs or barrages and the location of headworks should be known. The headworks should regulate the supplies of water entering the canal while rejecting the silt and sediment. This unit helps you to understand these aspects.

4.10 KEY WORDS

Barrages : A gated structure for diverting the river water into or more canals

Boulder Stage : The region through which the river traverses just after emerging from the hills has boulders in the bed and on the sides and this is the boulder stage.

Components of a Headworks : The various items in a barrage that have to be designed to divert the river flow into the canals and also to pass excess discharges without damaging the structure, besides passing sediments and fish.

Delta Stage : The river before it enters the sea develops a number of distributaries to form a delta. Any barrage constructed in such a region is said to be in the delta stage.

Headworks : They are structures constructed across a river and at the head of the offtaking channel.

Layout : The disposition of the various components of a diversion headworks is the layout.

Rocky Stage : The river in the hilly region has rock or very large boulders on the bed and the sides.

Site Selection : The location of a weir or a barrage should be selected with due consideration of various factors.

Trough Stage : The river passing through the alluvial plains after the boulder stage is in the trough stage. The bed consists of sand and silt.

Weirs : They are diversion structures without gates to regulate the flows.

4.11 ANSWERS TO SAQs

Answer all SAQs with respect to the preceding text.