

In this lesson, we shall discuss about the planning, layout and construction aspects of diversion structures, particularly barrages. This is because a weir, which is a raised hump-like structure across the river usually associated with small shutters for flow control may be suitable for very small diversion works but for larger rivers with more flexibility on flow control, a barrage is desirable. As may be observed from the figures, a barrage is actually a gated form of a weir and the table below lists the relative merits of each of the structure over the other.

Weir	Barrage
Low cost	High cost
Low control on flow	Relatively high control on flow and water levels by operation of gates
No provision for transport communication across the river	Usually, a road or a rail bridge can be conveniently and economically combined with a barrage wherever necessary
Chances of silting on the upstream is more	Silting may be controlled by judicious operation of gates
Afflux created is high due to relatively high weir crests	Due to low crest of the weirs (the ponding being done mostly by gate operation), the afflux during high floods is low. Since the gates may be lifted up fully, even above the high flood level.

In general, the trend in India for most of the modern water resources project involving diversion of water through a canal involves construction of a barrage, since a slightly more investment can bring in much larger benefits in the long run. Weirs may be used for very small scale hydraulic works.

In the subsequent sections of this lesson, we shall discuss only barrages and interested readers may refer to any standard textbook for details of weirs.

4.12 TYPES OF DAMS

Almost each dam that has been constructed all over the world is unique. This is so because a particular type is chosen because of the considerations of many factors, as discussed in subsequent sections. In fact, dam engineering brings together a range of disciplines, like structural, hydraulics and hydrology, geotechnical, environmental, etc.

Never the less, primary purpose of a dam is to provide for the safe retention and storage of water. Structurally, a dam must be stable against overturning and sliding, either or within the foundations. The rock or soil on which it stands must be competent to withstand the superimposed loads without crushing or undue yielding. The reservoir basin is created must be watertight and seepage through the foundation of the dam should be minimal.

Though each situation demands a unique proposal for the type of dam, a broad classification based on the construction material can be made in dividing the types of dams that have been commonly constructed as :

- (a) Embankment dams, which are constructed of earth fill and/or rock fill, and
- (b) Concrete dams, which are constructed of mass concrete.

Of course, there are some dams that were constructed using rubble masonry, like the Nagarjuna Sagar dam on the river Krishna. But mostly embankment dams are more common for technical and economical reasons all over the world, they account for nearly 80 percent of all the large dams that have been built in modern times. The two main types of dams are further explained in the following paragraphs.

Embankment Dams

These can be defined as dams constructed of natural materials excavated or obtained from the vicinity of the dam site. The materials available are utilized to the best advantage in relation to their characteristics as an engineered back fill defined zones within the dam section. The natural fill materials are placed and compacted without the addition of any binding agent. Two main types of embankment dams that are commonly constructed include the following :

Earth-fill or Earthen Embankments

These may be classified as dams use compacted soil for constructing the bulk of the dam volume. An earth fill dam is constructed primarily of selected engineering soils compacted uniformly and intensively in the relatively thin layers and at a controlled moisture content. Some of the common sections designed for earth fill embankment dams are shown in Figure 4.14.

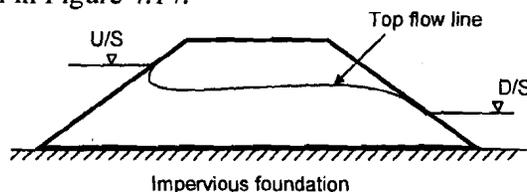


Figure 4.14. : Earthen Embankment Dams

Rock-fill Embankments

In these types of dams, there is an impervious core of compacted earth fill or a slender concrete or bituminous membrane but the bulk of the dam volume is made of coarse grained gravels, crushed rocks or boulders. Typical sections of rock fill dams are shown in Figure 4.15. The stability of the outer shell of a rock fill dam relies on the frictional forces acting in between each rock gravel piece which ensures its safety against sliding kind of failure during earth quakes.

It may be observed that shell of the rock fill dam is more permeable than that of an earth fill dam. Mostly, the water is prevented from flowing down by the impervious core of the rock fill dam.

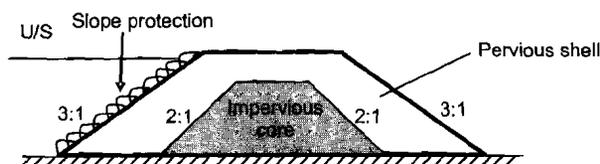


Figure 4.15 : Rockfill Embankment with Impervious Core

Embankment dams are advantageous in the following major aspects :

- (a) These are suitable for river valleys of any type: steep gorges or wide valleys.
- (b) Can adapt to a broad range of foundation conditions, ranging from good rock to even permeable soil type of foundation.

- (c) Uses naturally available materials.
- (d) Relatively less costly

Amongst the disadvantages, it may be said that they have greater susceptibility to damage than concrete dams due to the possibility of getting washed away during an over tapping of the spill way which may occur if there is a flash flood in the river and the gates of the spill way are not operated in time or the spill way itself is of inadequate capacity.

A further disadvantage of the embankment dam when compared to a concrete dam is that the former requires to have a separate spill way in contrast to the latter, where the spill way may be integrated within the dam body itself. Also earthen embankments are prone to concealed leakage, perhaps due to faulty construction or internal erosion in the dam body or in a pervious foundation.

Concrete Dams

The use of mass concrete in dam construction started from about 1900 for reasons of ease of construction and to suit complex designs, like having spill way within the dam body. From about 1950 onwards, mass concrete came to be strengthened by the use of additives like slag or pulverized fuel ash, in order to reduce temperature induced problems or avoid undesirable cracking or to reduce the total cost of the project.

Amongst concrete dams, too, there are many varieties, the principal types of which described below :

Gravity Dams

A gravity dam is one which depends entirely on its own mass for stability (Figure 4.16). The basic gravity profile is triangular in shape, but for practical purposes, is modified at the top. Some gravity dams are slightly curved in plan, with the curvature being towards the river upstream. It is mostly due to aesthetic and other reasons, rather than having an arch action for providing greater stability.

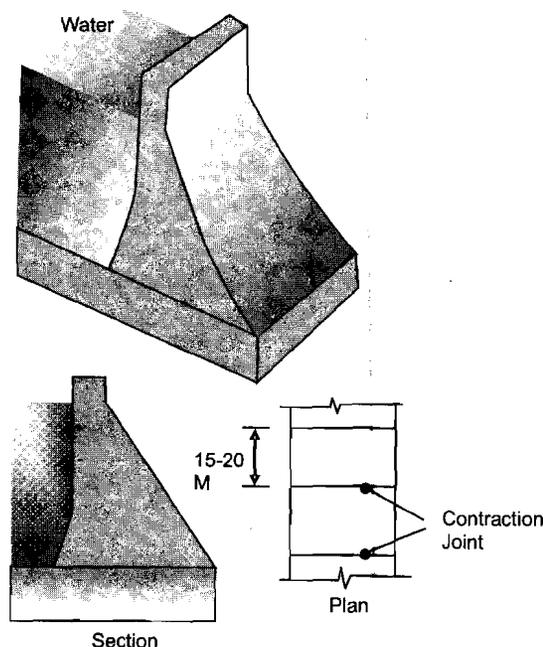


Figure 4.16 : Concrete Gravity Dam

Buttress Dams

This type of dams consist of a continuous upstream face supported at regular intervals by buttress walls on the down stream side (Figure 4.15). These dams are generally lighter than the solid type of dam but likely to induce slightly higher stresses at the foundation since most of the load now passes through the buttress walls and not spread uniformly over the foundation as in a solid gravity dam.

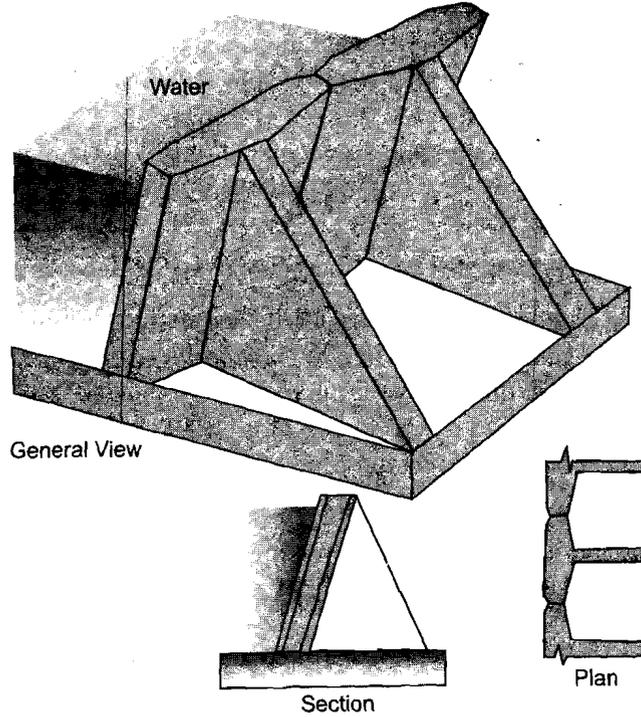


Figure 4.17 : Buttress Dam

Arch Dams

These types of dams have considerable upstream curvature in plan and rely on an arching action on the abutments through which it passes most of the water load on to the walls of the river valley (Figure 4.18). This type of dam is structurally more efficient gravity dams and greatly reduces the volume of concrete required. Of course, a prime necessity in constructing an arch dam is to have sound foundation and abutments.

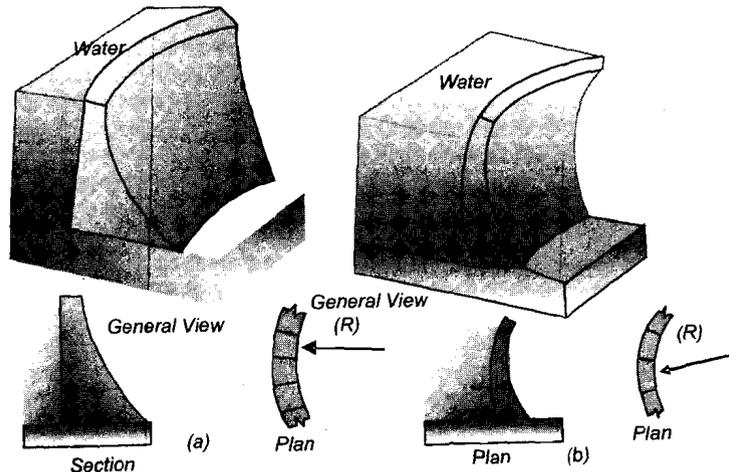


Figure 4.18 : Arch Gravity Dam