# CHAPTER 1

## INTRODUCTION

### *1.1 Introduction*

Hydraulic structures are human-made systems interacting with surface runoff in urban and rural environments including structures to assist stormwater drainage, flood mitigation, coastal protection, or enhancing and controlling flows in rivers and other water bodies. A hydraulic structure is a structure submerged or partially submerged in any body of water, which disrupts the natural flow of water. They can be used to divert, disrupt or completely stop the flow. A hydraulic structure can be built in rivers, a sea, or any body of water where there is a need for a change in the natural flow of water.

The structure may is built across a natural stream to divert, control, store, and manage the water flow: for example, a weir across a waterway and its upstream reservoir controlling both upstream and downstream water levels (Figs. 1).

Figure (1): Weir structure

Hydraulic structures can be designed pro-actively to control the water flow motion: for example, a series of drop structures along a mountain river course built to stabilize the river bed by dissipating the flow energy along the drops.
The construction of weirs, dams, and hydraulic structures is possibly the oldest and most important civil engineering activity. Life on our planet is totally dependent upon water and only two species build hydraulic structures: humans and beavers. The latters are called "*the engineers of Nature*". Although the date and location of the most ancient hydraulic structures (see Fig. 2) are unknown, some very famous heritage structure

includes the Sumerian irrigation canals in Mesopotamia (BC 3,000), the Sadd-El-Kafara dam in Egypt (BC 2,500), the Marib dam and its irrigation canals in Yemen (BC 750), the Dujianyan irrigation system in China (BC 256), and the Vichansao canal and its diversion structure in the Moche Valley, South America (AD 200).


Marib dam-Yemen                Sumerian irrigation canal-Iraq

Sadd-el-Kafara dam- Egypt built in the the

The Cornalvo Dam, a Roman dam in 1st or 2nd century AD, still supplies water to People of Meriden- Spain

Figure (2): Some of very famous heritage structure

The two key technical challenges in hydraulic structure design are the conveyance of water and dissipation of kinetic energy. Conveyance implies the transport of water, for example, into the spillway of a dam. The conveyance of the structure is closely linked to the intake design, for example the spillway crest, and chute design (Fig. 3). Its estimate is based upon fundamental fluid dynamic calculations, with a range of proven solutions. Figure 3 illustrates a rounded spillway crest designed to increase the discharge capacity at design flow compared to a broad crest. The dissipation of energy occurs along the chute and at its downstream end. The available energy can be very significant and kinetic energy dissipation must take place safely before the water rejoins the natural river course.

Figure (3): Spillway structure

1.2. *Types of Hydraulic Structures*

Hydraulic structures are classified according to the purpose of its function as:

1- ***Storage Structures***: The function is to store water such as dams (see Fig.4) and tanks.

Figure (4): Dam structure and its reservoir

2- ***Conveyance Structures***: the function is to convey water from place to another such as pipelines, siphons, culverts (Fig. 5), tunnels, aqueducts and open channels.

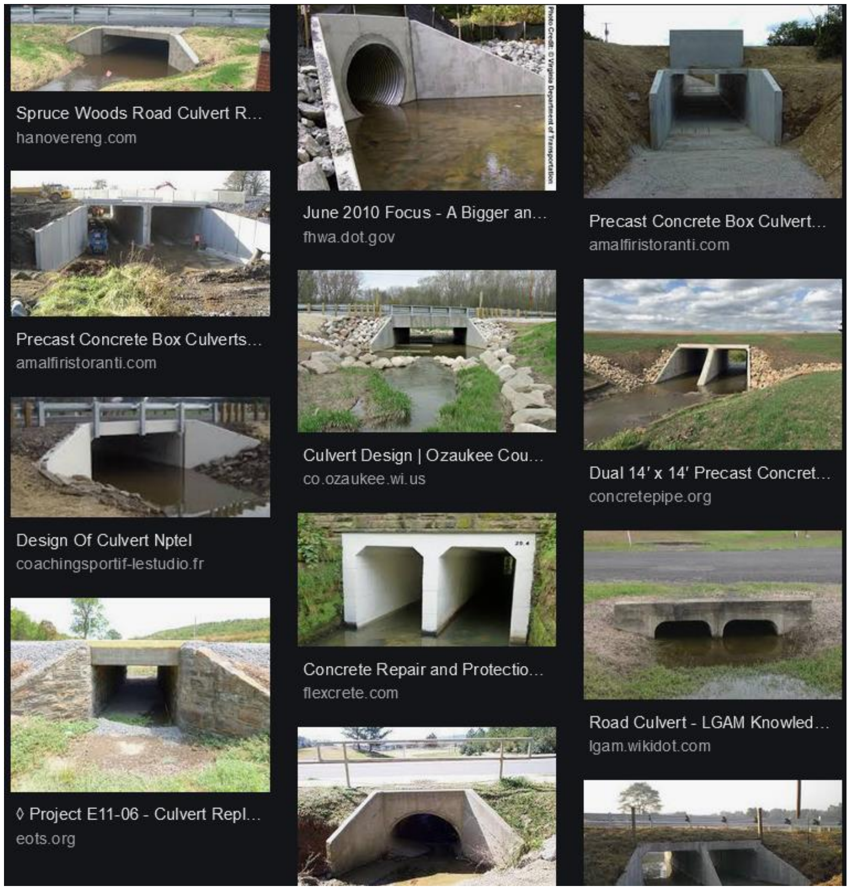


Figure (5): Culvert structure

3- ***Flow Diversion Structures***: the function is to regulate and divert the quantities of flow to another structures or canals such as barrages and regulators (Fig. 6).

(a) Barrage (b) Canal head regulator

Figures (6a, and 6b): Barrage and canal head regulator structures

4- ***Flow Measurement Structures***: the function is to measure the flow passing through it such as weirs, orifices, nozzles, venturi meters and parshall flumes.

5- ***Energy Dissipation Structures***: the function is to protect the floor of a hydraulic structure from erosion and damage due to severe waves which impact with the body of structure such as stilling basins, surge tanks, check dams and vertical drop.

6- ***Power Stations***: the function of these structure is to convert energy from a case to another such as pumps, turbines and rams.

7- ***Sediment and Chemical Control Structures***: the function is to control or remove sediments and other pollutants such as sedimentation tanks, screens, traps, filters and mixing basins.

8- ***River Training and Waterway Stabilization Structures***: the function is to maintain river channel and water transportation such as levees, cutoffs, locks, piers dikes, groins, breakwaters (Fig. 7), jetties and revetments.

Figure (7): A spur dike and breakwater structure

## 1.3. ***Percolation beneath Heading up of Hydraulic Structures***

The hydraulic structures such as barrages, regulators, culverts, etc…, may either founded on an impervious solid rock foundation or a pervious foundation. It is subjected to seepage of water beneath the structure in addition to all other forces to which will be subjected. When founded on an impervious rock foundation, the water seeping below the body of the hydraulic structure, endangers the stability of the structures may cause its failure.

### 1.4. ***Causes of Failure of Hydraulic Structures Founded on Pervious Foundations***

#### 1.4.1. ***Failure by Piping or Undermining***

Water starts seeping under the base of hydraulic structure. It starts from U/S side and tries to exit at the D/S end of the impervious floor. At the point of the exit, the exit gradient may become more than the critical gradient, in which cause, the water starts dislodging the soil particles and carrying it away with it causing formulation a hole in the subsoil. So, formed resulting in the failure of the structure. Piping can have prevented by the following methods:

a. ***By providing sufficiently long impervious floor***

This long length will reduce the exit velocity and exit gradient. As the water has to travel along distance beneath the floor, its head will sufficiently have lost before it exits and its velocity will be such that it cannot wash away any soil or sand particles.

b. ***By providing piles at both U/S and D/S ends****:*

This measure also results is increasing the path of the travel of seepage water and hence it decreases its exit velocity and exit gradient.

#### 1.4.2. ***Failure by Direct Uplift Pressure***

The water seeping below the structure exerts an uplift pressure on the floor of the structure if this pressure is not counter balance by the weight of concrete or masonry floor. The structure will fail by a rupture of a part of the floor. The pervious concept of the hydraulic structure due to subsurface flow where introduce by many engineers on the bases of experiments and the research work.