



Abdelhafid University Center Bousouf - Mila
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Hydraulic works

– Course 1 –

Chapter 01 : *Generalities, statistics, roles and breaks*



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Course Objectives 1

This chapter aims to present general information on the works hydraulics , in particular their definition , their functions , their distribution statistics , their elements constructive , as well as design procedures . It deals with also risks potential for dam failure and consequences associated .

- Understand the nature and role of hydraulic structures.
- Identify the main constituent elements of a dam.
- Analyze the geographical distribution of dams on a national and global scale.
- Describe the different phases of designing a hydraulic structure.
- Understand the risks associated with dam failure and their consequences.

I.1 Introduction



The works which serve to implement one or more branches of water economy are called hydraulic works.

Depending on whether these works are built on rivers or lakes, we distinguish between fluvial and lagoon works.

Hydraulic works have three particularities:

- ✓ The constant action of water can lead to mechanical wear, cavitation of parts of structures in contact with the current and the rupture of certain structures.
- ✓ The construction of a structure has a significant impact on the environment (ecological change) and results in a change in the natural flow regime. In the case of a dam, this change results in a rise in the water level upstream and increasingly fine sediment deposits as one approaches the dam.

- ✓ Infiltration erosion phenomena threaten their stability

1.2 Definition and aims

A dam is a hydrotechnical structure installed on the watercourse of a watershed to accumulate runoff water in a natural reservoir.

A dam is a structure placed across a watercourse, intended to retain and store water or to divert it.

The Larousse dictionary defines the word dam as "an artificial structure cutting across the bed of a watercourse and serving to regulate it, to supply towns with water or to irrigate crops, or to produce energy."

Dams have several functions, their construction is dictated by necessity either:

In Algeria, a reservoir is mainly used to:

- Drinking water supply to the population
- Irrigation of agricultural land during dry periods,
- Hydroelectric power production,
- Creation of landscapes for rest areas or sports centers.
- Fish farming or breeding of other aquatic animal or plant species
- Regulation of watercourses (flood control , with the aim of protecting property and people downstream),
- Fire fighting (water reserve)

1.3 Constructive elements of a dam .

1.3.1 Dam body

- Definition of terms used

A dam is a structure built in the bed of a watercourse with the aim of creating a difference in level between the bodies of water located upstream and downstream. Consider the cross-section of a dam shown in (**Figure 1-1**) .

The lake or artificial basin upstream of a dam, in which a certain quantity of water is accumulated is called a reservoir. The morphology of the area covered by the reservoir is the basin. The water reservoir is a reservoir whose operation is carried out at variable levels in order to store and release water.

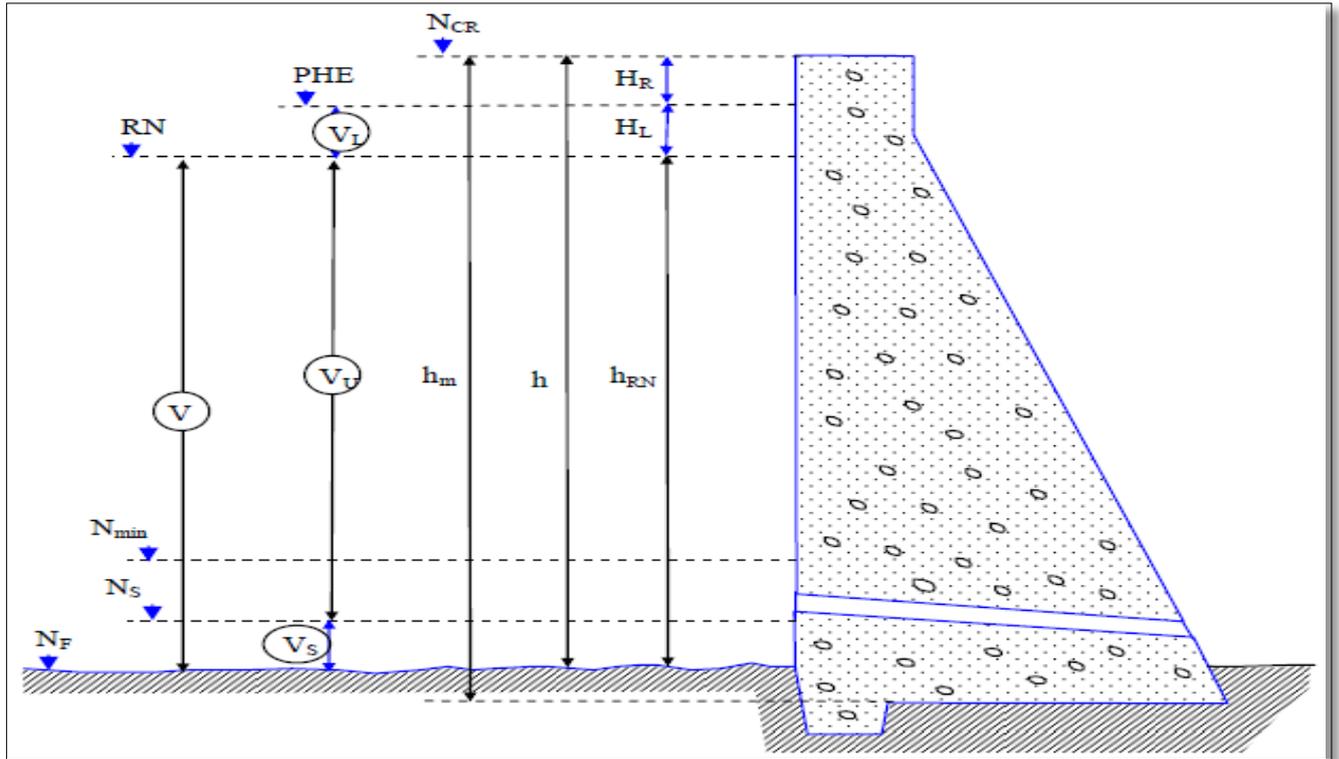


Figure 1.1: Characteristics of the capacity of a reservoir

Term s	Definitions	Sym bols
Level or rating of deposits Solids (m)	Rating corresponding to the solid deposit in the reservoir	N s
Level or side of the bed of The Wadi (m)	Rating of the lowest point of the bottom of the river bed Water in correspondence with the upstream facing	N F
Minimum operating level or elevation (m)	Minimum water level in the reservoir or the accumulated water can be derived by the intake Water for intended use	N MIN
Normal level or elevation of the reservoir (m)	Normal level in the reservoir at which discharge begins into the spillway Floods.	RN
Highest water level or elevation (m)	Maximum level at which the water level in the reservoir can reach in the event of the most significant flood event expected, Exclusion of wave elevation	PHE
Ridge level or elevation (m)	Level of the dam crest plan, excluding parapets and any protective walls against the waves.	N CR
Height of the reservoir Normal (m)	Difference in level between the normal level of the reservoir and that of the wadi bed.	h RN
Height above ground (m)	Difference in altitude between the level of the ridge and that of the	h

	wadi bed	
Flood elevation (m)	Difference in level between the level of the highest waters and that of the normal reservoir. This overfilling represents the maximum load exerted on the spillway in correspondence with the design flood.	h L
Revenge (m)	Difference in altitude between the crest level and the level of the highest waters.	h R
Maximum dam height (m)	Difference in height between the level of the crest plane and that of the lowest point of the foundation surface (excluding any substructures sealing)	h m
Dead slice (m³)	Retention volume located below the level minimal exploitation and intended for silting.	V S
Useful volume of the reservoir (m³)	Volume of water between the normal level of the reservoir and the minimum operating level: this volume includes the usable portion and that corresponding to losses by evaporation and by infiltration .	SEE N
Rolling volume	Volume between the highest rating waters and the normal level of the reservoir.	V L
Total volume or capacity of the retention (m³)	Total volume of water between the normal level of the reservoir and the level of the wadi bed.	V
Surface or area of the retention (m²)	Water body area for the normal level of restraint .	S

1.3.2- Ancillary works.

a. Flood spillway.

It is a work which allows the passage of floods when the dam is filled.

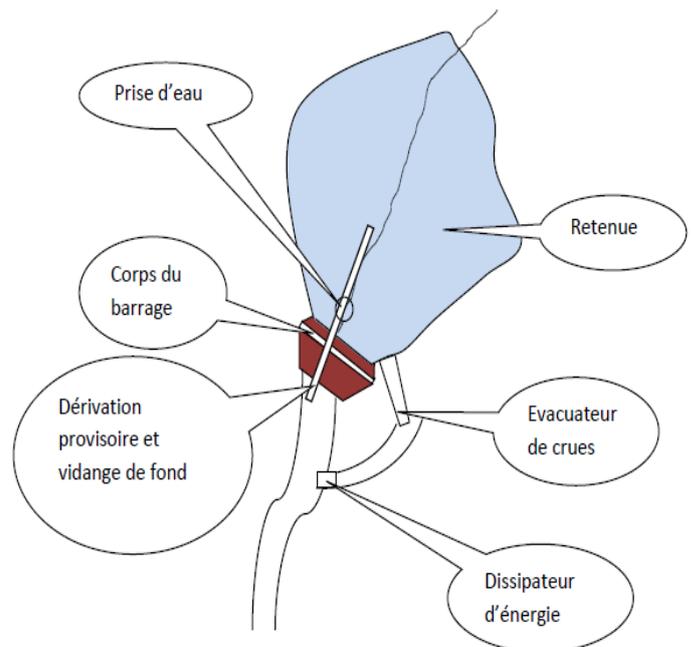
b. Temporary derivation

The temporary derivation is associated with a cofferdam , these works are used to protect from flood waters during the construction of the work.

c. Water intake.

It is a structure that allows water to be collected for its use.

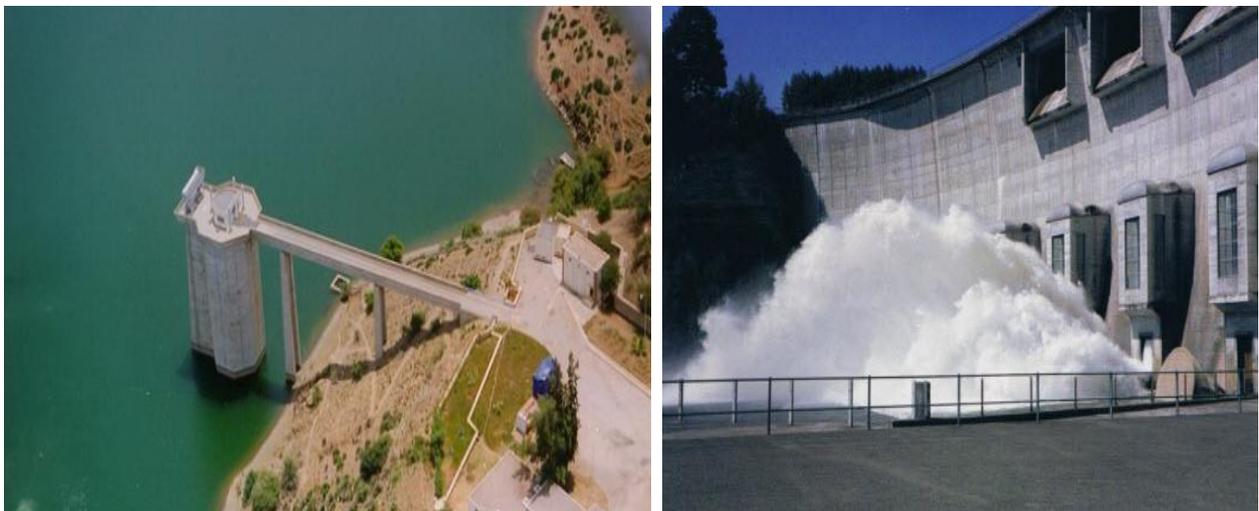
d. bottom drain.



It is a structure which allows the reservoir to be partially or completely emptied.



a. Flood spillway. b. Temporary diversion



c. Water intake. d. Bottom drain.

1.4 . Dams today

How many dams are there in the world?

There are currently over 45,000 dams in the world and two new ones are opened every day.

Three-quarters of large dams are in three countries: China (46%), the United States (14%) and India (9%) .

1.5 Statistics on dams in Algeria

Currently, the water resources sector has 80 large and medium-sized dams with a capacity of 8.6 billion (m³)

- 15 dams in the West region (Djorf torba , Beni Bahdel , guergar , sikkak , Bentaiba ...)

- 17 dams in the Cheliff region (Oued el Fedda , Sidi Yaakoub , etc.)
- The Central region with its 18 dams (Keddara , Taksebt , Koudiet Asserdoun ...)
- 30 dams in the East (Beni Harroune , Timgade , Tichy, etc.)

The government intends to increase the total number of dams in Algeria to 140 by 2030, thereby achieving a storage capacity of nearly 12 billion cubic meters across the country. In addition to increasing dam capacity, Algeria has also worked to develop its drinking water production from seawater , and several desalination plants built since 2000 provide the population with freshwater from Mediterranean seawater.

1.6 Design procedures for hydraulic structures

When designing a hydraulic structure, as in any other project Civil Engineering, we can distinguish three well-characterized phases:

1.6.1- First phase: preliminary studies or preliminary draft summary (APS)

It concerns the **reconnaissance** and general studies of the area to be developed with a view to:

- To establish an inventory of achievements likely to satisfy needs either already expressed or listed in the area
- To assess the economic interest of carrying out these developments, it includes the following stages:
 - **Collection of available data:** cartographic documents, climatic data, geological information, data relating to agricultural practices and water requirements.
- **Inventories of potential sites and selection criteria :** topographical, geological and geotechnical, hydrological, proximity to places of use, economic criteria, reconnaissance of sites, reconnaissance geological and geotechnical, rapid topographical site examination, recognition of the irrigable perimeter and/or rural agglomerations.

The preliminary studies to be carried out are:

- 1- Topographical study.
- 2- Hydrological study.
- 3- Geological and geotechnical study.
- 4- Needs assessment.
- 5- Evaluation of the characteristics of the development.
- 6- Choice of sites.

7- Schematics of the developments - Cost estimates.

8- Implementation program.

10- Preparation of the summary report.

1.6.2- Second phase: Detailed Preliminary Design (DPD) study

It concerns the studies of the variants preselected during the preliminary phase. These are the detailed preliminary project studies which will enable the developments to be carried out.

The detailed preliminary design studies include:

- 1- Surveys and topographic studies.
- 2- Hydrological studies.
- 3- Geological and geotechnical studies.
- 4- Assessment of water needs.
- 5- Regularization study.
- 6- Project impact studies.
- 7- Types, characteristics and dimensions of the works.
- 8- Technical requirements.
- 9- Preliminary measurement and detailed estimate.

1.6.3- Third phase: studies of the construction of the works (execution file)

It concerns the organizational conditions, the technical requirements for proper execution and the controls which must be implemented during the construction of the works.

These studies focus on the following aspects:

- Resources for carrying out the project (machinery, materials, consumables, personnel).
- Organization of the site.
- Execution of works (sequence of operations, main works, work control).

1.7 The risk of dam failure

The partial or total destruction of a dam can be due to different causes:

-**Technical:** malfunction of valves allowing water to be evacuated during floods; design, construction or material defects, aging of installations.

- **Natural:** earthquakes, exceptional floods, landslides (either from the foundation or supports of the structure, or from the land surrounding the reservoir and causing a spill onto the dam).

- **Causes human**

Accidents caused by human activity can be summed up as: incomplete preliminary studies, insufficient execution control, operating errors, lack of monitoring and maintenance.

1.7.1 type of dam failure:

The type of rupture depends on the specific characteristics of the dam. Thus, it can be:

- **Progressive**: in the case of embankment dams, by regressive erosion, following submersion of the structure or a leak through it;

- **Sudden** in the case of concrete dams, by overturning or sliding of one or more blocks.

A dam failure causes the formation of a submersion wave resulting in a sudden rise in the water level downstream.

The damage caused can then be considerable for:

- **Living beings** : drowning (flooding) , burial...
- **Property** : destruction and damage to buildings and structures (bridges, roads, etc.) .
- **The environment** : destruction of flora and fauna, disappearance of arable land, various pollutions, mud, debris, etc.

Useful links

- https://youtu.be/5ZKKmQJps_0
- <https://youtu.be/m2YIVPKTE84>

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