IQRA NATIONAL UNIVERSITY

ENGINEERING GEOLOGY

Lecture 03

An overview of Dam & Geological Consideration

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What is Dam?

- Dams are massive barriers built across rivers and streams to confine and utilize the flow of water for human purposes such as irrigation and generation of hydroelectricity. This confinement of water creates lakes or reservoirs.
- The first known dam was built across the Nile River to protect the city of Memphis from flooding.
- According to (Patrick) campaigns director of the International Rivers Network, over 800,000 dams have been constructed worldwide for drinking water, flood control, hydropower, irrigation, navigation, and water storage.

Dams are created for the following objectives:

Generation of hydropower energy

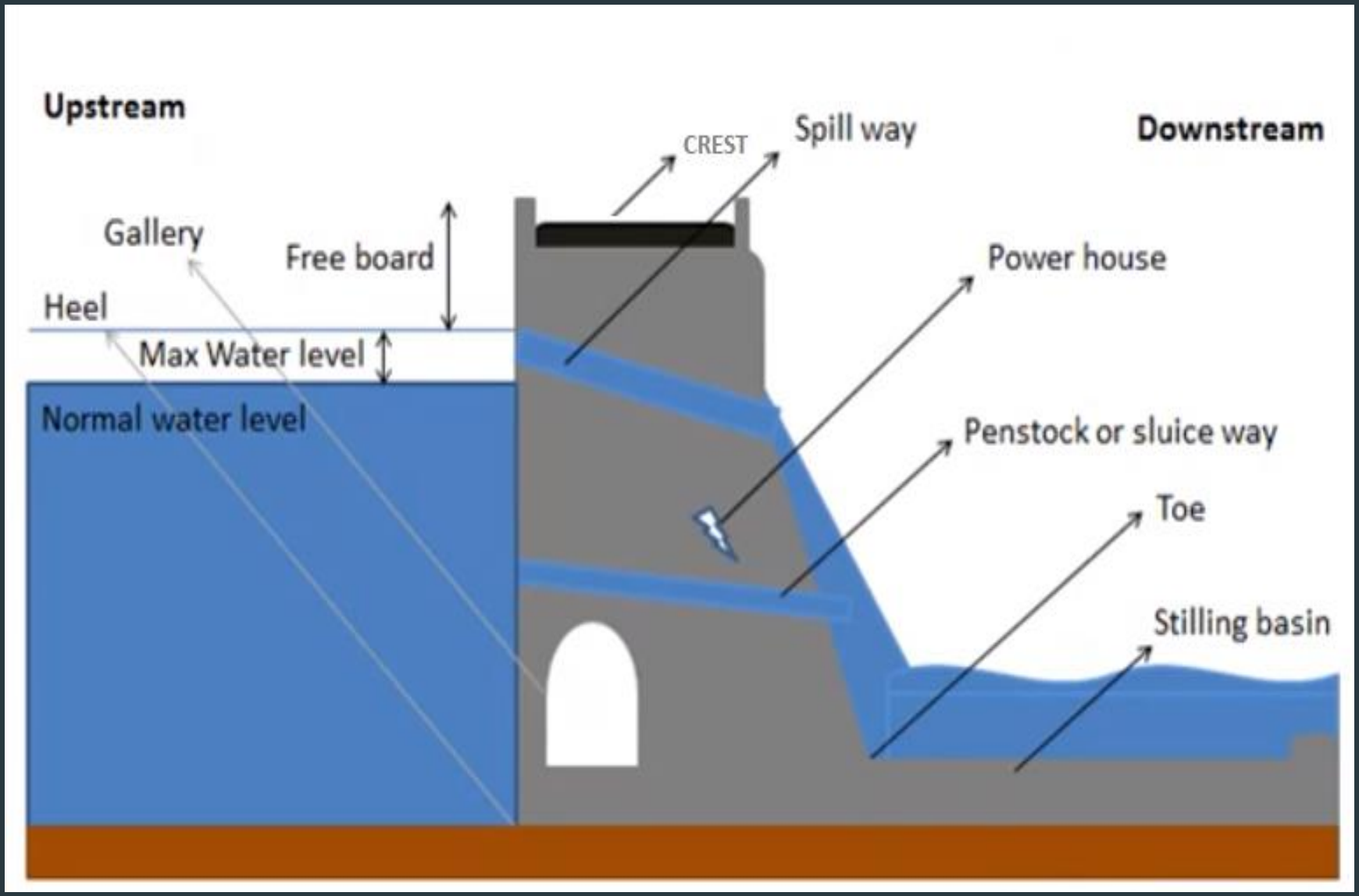
Providing water for irrigation facilities Fish farming

Controlling of floods

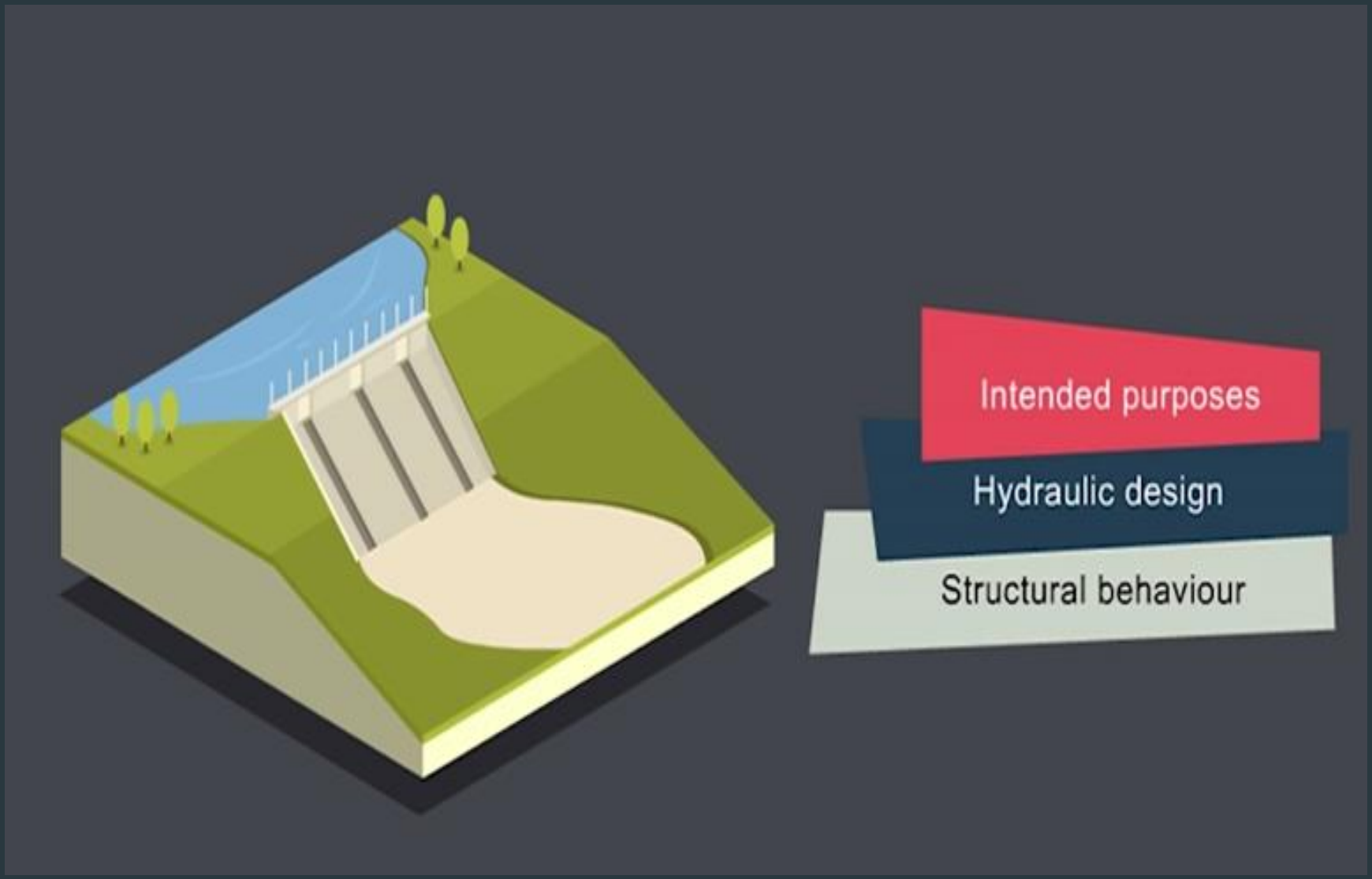
Water supply for domestic consumption

Providing navigational facilities

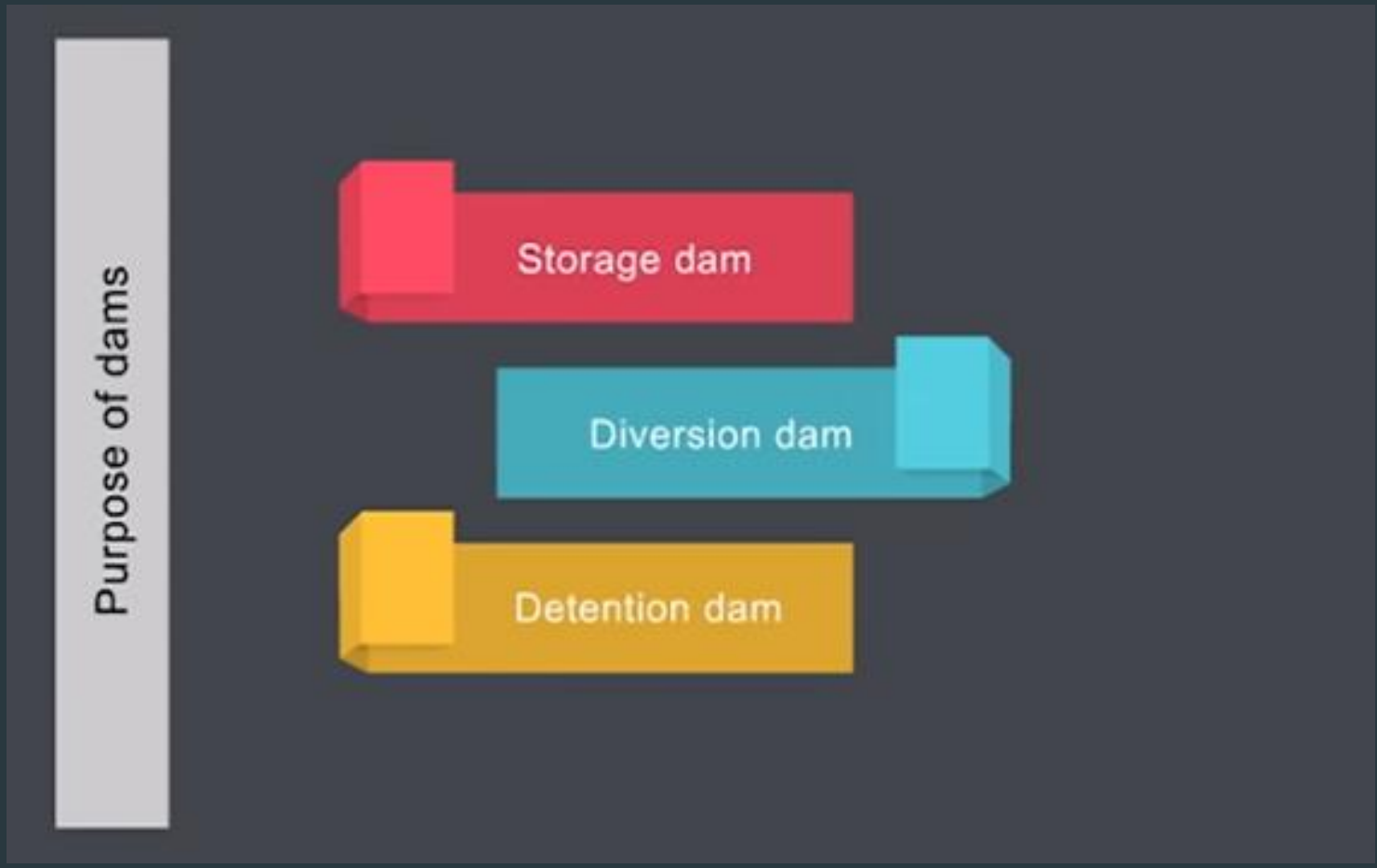
PARTS OF THE DAM STRUCTURE



CLASSIFICATION OF DAMS



INTENDED PURPOSE



STORAGE DAM

- Storage dams are used for storing water. the stored water is later on used during the period of deficient water supply.

DIVERSION DAM

- The water level raises in river, the excess water is diverted to ditches, canals etc through diversion system so as to save it from flooding.

DETENTION DAM

- Constructed to store water during the time of flood, later on the stored water is gradually released with safe rate without effecting the surrounding region.

HYDRAULIC DESIGN

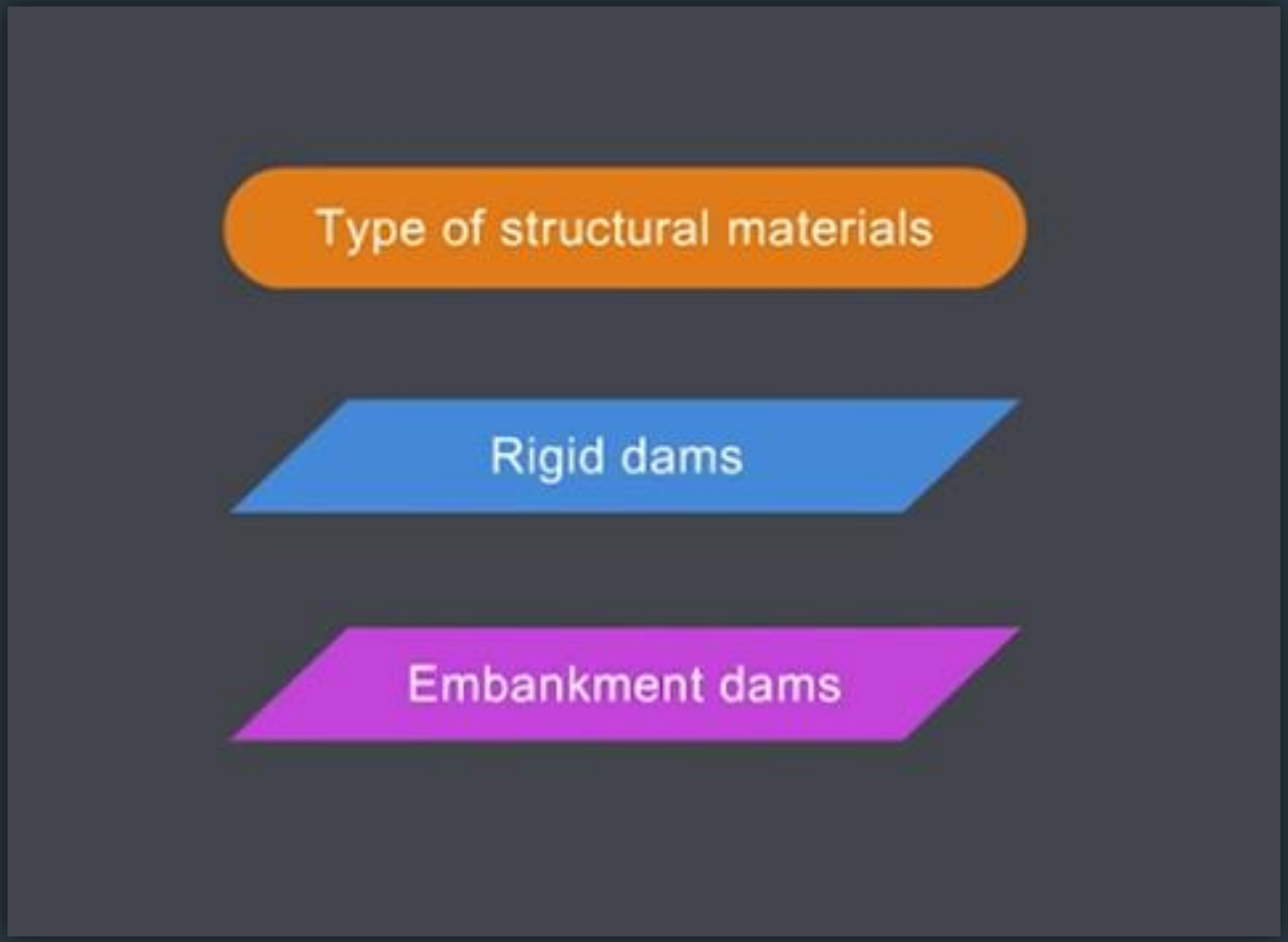
OVERFLOW DAM

- Carry excessive/surplus water over the crest.

NON-OVERFLOW DAM

- Constructed with high elevated levels to prevent overflow of water during heavy floods.

STRUCTURAL MATERIALS



RIGID DAMS

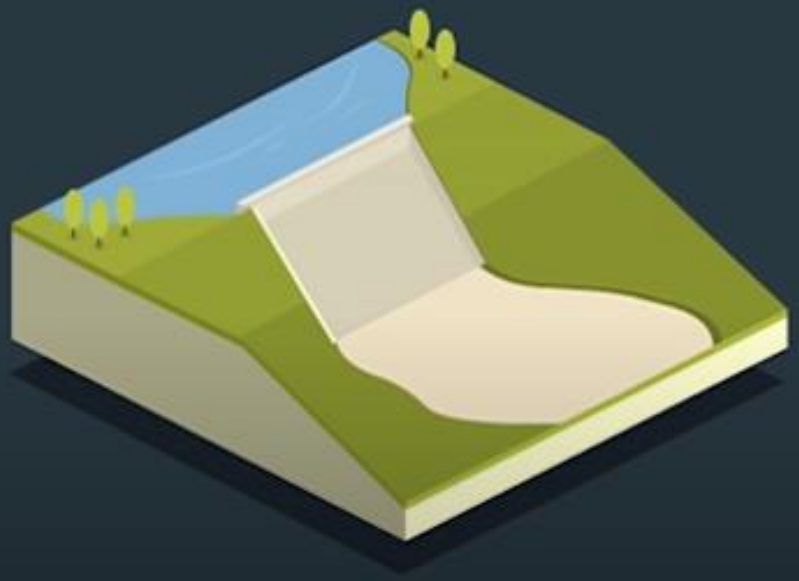
- Constructed of Rigid material like; (concrete, steel, masonry).

Embankment Dams

- Constructed with non rigid materials like such as ; earth fill (soil),Rock fill etc .


Types of dams
Gravity dam
Arch dam
Buttress dam
Steel dam
Timber dam
Earth and rock-fill dam

Gravity dams

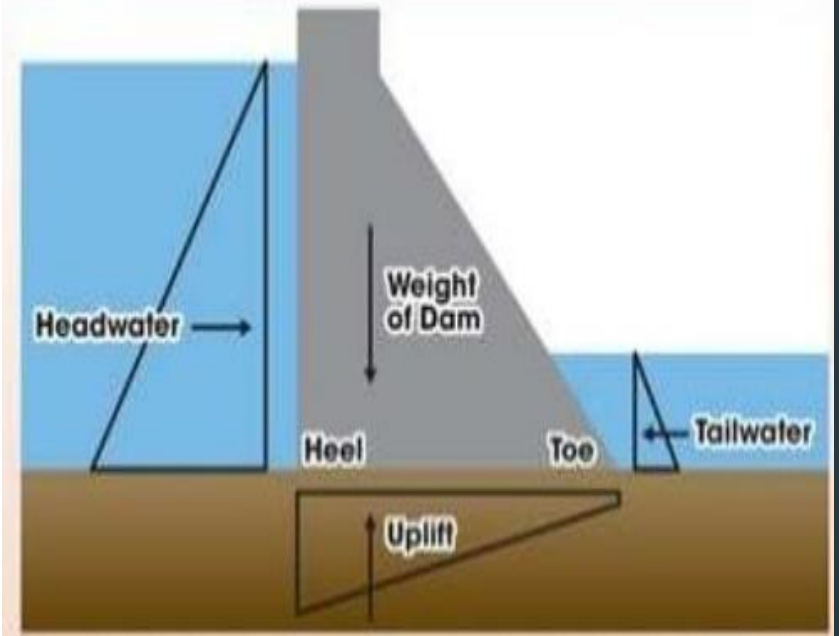


- Made of rigid materials.
- Pressure is resisted by weight of dam itself.
- Dam is relatively strong, durable and need less maintenance.
- Initial cost is very high.
- Skilled labor.

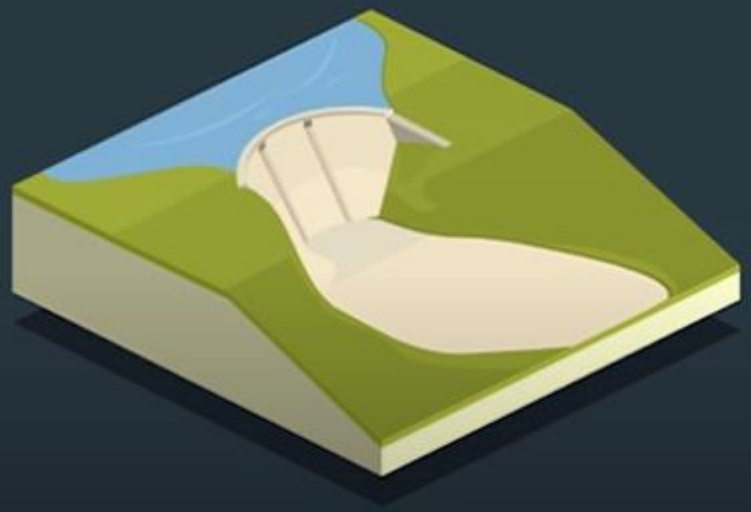
Gravity dams

- Storage dams
- Non-flow dams
- Rigid dams

Gravity Dam

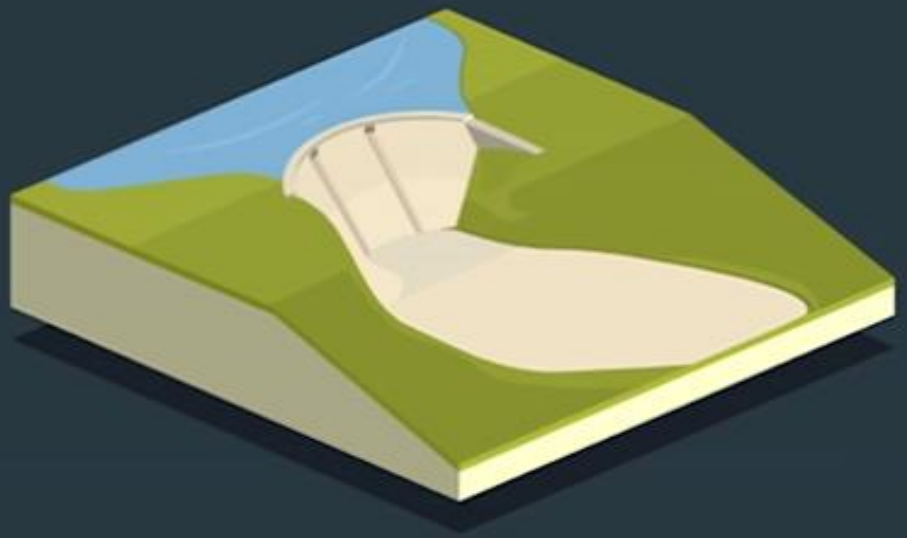


Arch dams



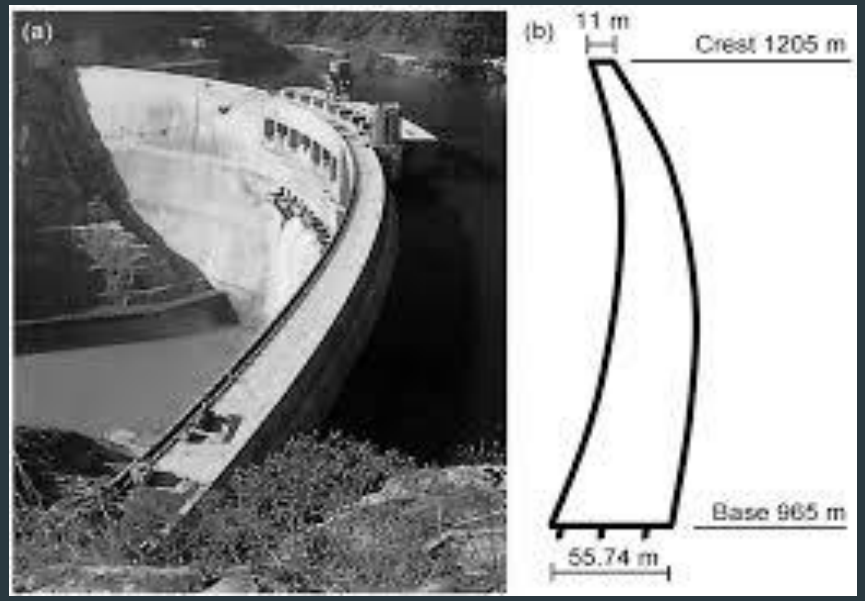
- Made of rigid materials.
- Pressure is resisted horizontal by side embankments.
- Constructed mostly at deep narrow valley.
- Arch dam is smaller than the Gravity dam.
- Skilled labor.

Arch dams



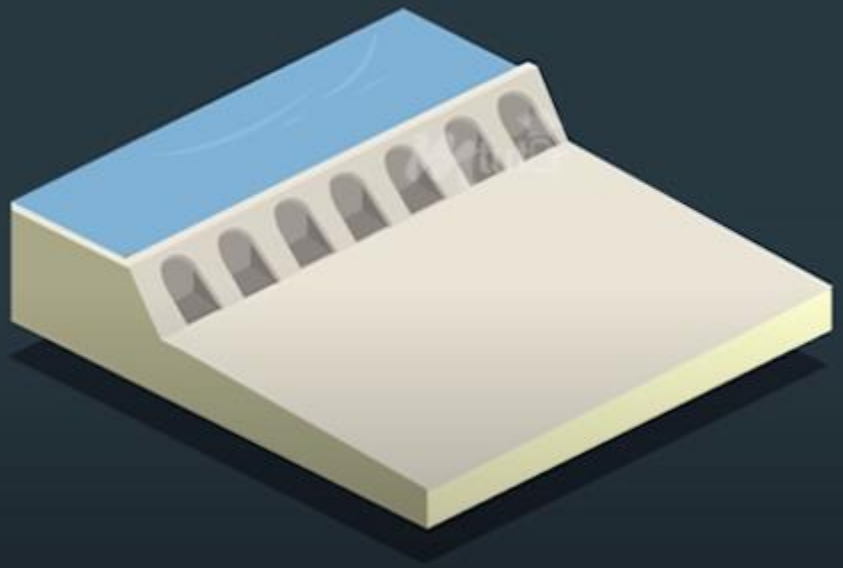
Storage dams

Rigid dams



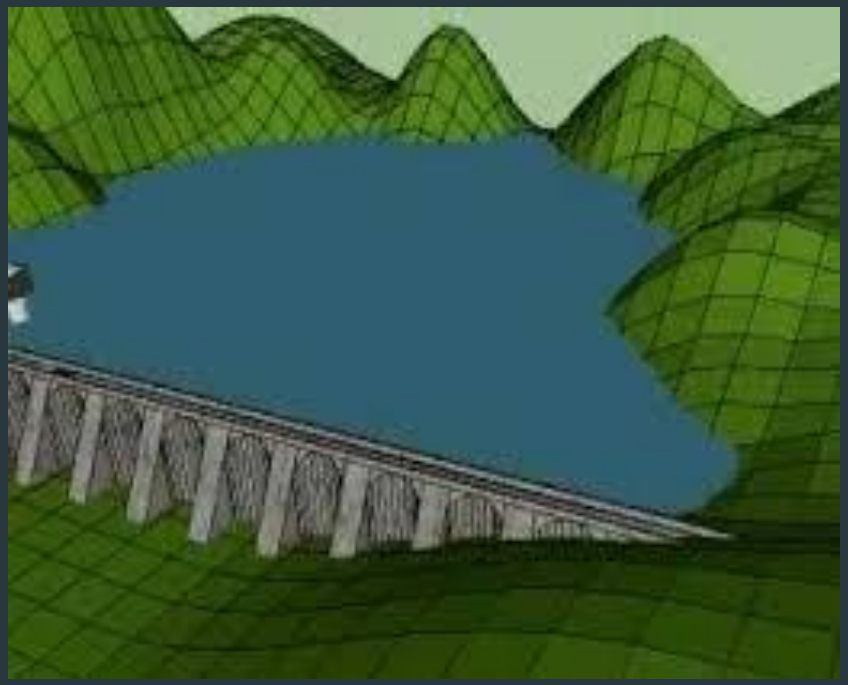
Arch Dam

Buttress dams

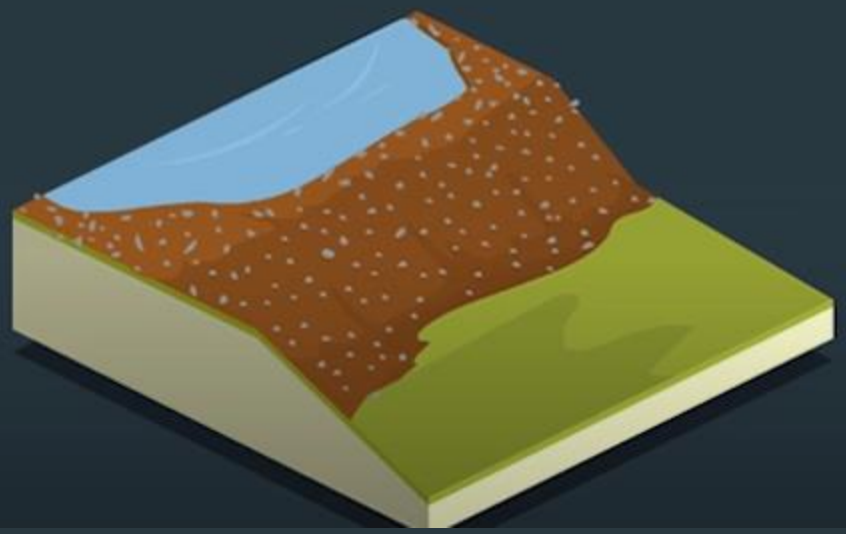


- Made of rigid materials..
-Constructed with numbers of buttress.
- divided space into number of span.
- buttress dam is less in weight than the Gravity dam.
- Skilled labor.

Buttress dam



Earth and rock-fill dam



- Constructed of locally available materials such as soil, gravels etc
- Dam filled with soil (earth fill) is known as earth fill dam & dam filled with gravels are known as rock fill dam.
- Usually preferred where base soil is considered weak and structural dam is no possible.
-Un-Skilled labor.
- High sensitive to floods.

Steel and timber Dam

- A steel dam is a type of dam briefly experimented with around the start of the 20th century which uses steel plating (at an angle) and load-bearing beams as the structure.
- The steel dams were an (arguably failed) experiment.

- Timber dams were widely used in the early part of the industrial revolution and in frontier areas due to ease and speed of construction.
- Rarely built in modern times because of their relatively short lifespan and the limited height to which they can be built, timber dams must be kept constantly wet in order to maintain their water retention properties and limit deterioration by rot, similar to a barrel.

Preliminary Geological Investigations of Dam Construction:

1. Topographical Studies.
2. Reservoir Location.
3. Petrology studies.
4. Mineralogy Studies
5. Structural Geological Studies.
6. Geological Factors Like Foundation Conditions, Water tightness of reservoir, availability of construction material.
7. General examination of rocks.
8. Indirect study methods for subsurface investigations.
9. Preliminary Drill Hole Study.

Detailed Geological Investigations for Dams Site Selection:

- Study of Geological Toposheet.
- Study of the Area with reference to Geology.
- Study of Rock Types.
- Study of Structural Geology of the Area.
- History of the Area with reference to Rainfall Data.
- Study of Stream Channels with Diff. Order.
- Study of Seismic Data of the Area.
- Geomorphological Study.
- Preparation of Geological Map of the area in detail.
- Study of Core Drill Data and its interpretation.
- Detailed Engg. Geological Properties of the area.

Selection of sites

Selection of sites is based on following basis:

Topographically: most suitable place must be chosen for construction. Ideally it must be a narrow gorge or a small valley with enough catchment area available behind so that calculated amount of water can be easily stored in the reservoir created upstream.

Location of spillway: All dam should have an adequate spillway for passing flood flows. If a river gorge is narrow, then there may not be sufficient spillway width available and a suitable location on the periphery of the reservoir has to be found to locate a spillway.

- Possibility of river diversion during construction : The way, river can be diverted at a particular site for making way for construction of the dam may affect the design of the dam and also the construction schedule.
- Sedimentation possibilities :The average quantity of sediment carried by the river has to be known, as precisely as possible, which would give an idea of the rate at which a proposed reservoir way get filled up.

Technically:

The site must be sound as possible: strong, impermeable and stable. Strong rocks make the job of designer easy. Impermeable sites ensure better storage inventories. Site must be stable with respect to seismic shocks slope failures around dam.

Constructionally:

The site should be far from the materials which will be used for the construction. Their non-availability will make the cost of project high.

Human welfare:

site selection should be done in such a way that it must cause minimum damage to public in the destruction or failure.

Geological characters for investigation

Geology of the site

a.Lithology :

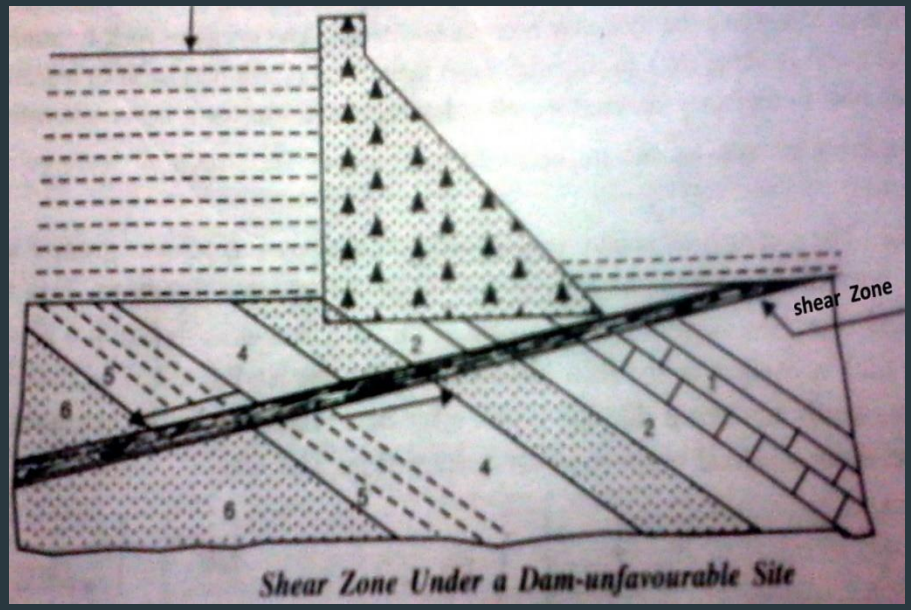
surface and subsurface studies must be carried out. These studies reveal the type, the composition and texture of the rocks along the valley floor.

b.Structures:

Dip and strike

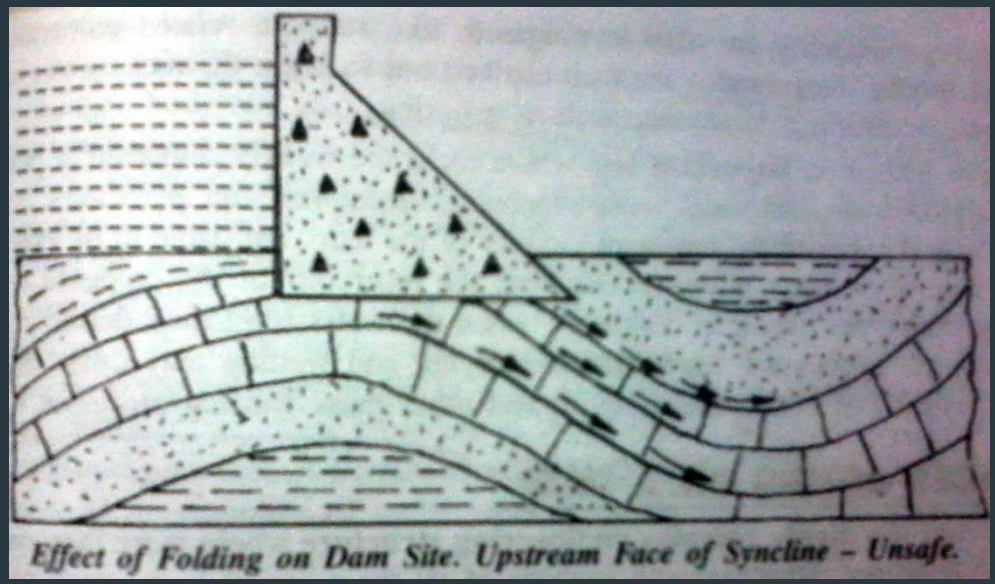
Faults:

Dams founded on the fault zones are most liable to the shocks during an earthquake. Generally the small scale fault zones can be treated effectively by grouting.



Folds:

the effects of fold on rock are shattering and jointing along the axial planes and stressing of limbs. In the synclinal region dams placed on the upstream limbs have the risk of leakage from beneath the dam.



Engineering properties of rocks:

a. Strength parameter:

it consist of three investigations – laboratory, in-situ static and dynamic.

- The compressive and shearing strength of the rocks are estimated by laboratory test.
- These tests are complimented with in-situ studies using static and dynamic studies.
- Static study: by this test settlements and strains are recorded with different loadings which is used to estimate the bearing strength, modulus of elasticity and Poisson's ratio.
- The dynamic method involve creating seismic waves artificially at selected locations and recording the velocity of the shock waves through the rocks of the sites. The shock wave velocity relates to the density, rigidity, porosity and permeability of the rocks at the site.

Porosity and permeability:

A dam is a water impounding structure. So water must not find easy avenues to escape other than provided in design such as spillways. So porosity and permeability of the rocks are tested both in laboratory and in-situ. Artificial treatment is given to the critical zones such as grouting to make the rocks water tight

Material availability:

If the cost of transportation of construction material is excessively high, then an alternate design with locally available materials, have to be considered.

Seismicity :

It is very important to analyse the behaviour of the dam under earth quake vibrations thereby making it possible for the designer to check if a particular section of the dam is suitable or not.

END OF THE LECTURE