

GEOLOGY OF DAMS, RESERVOIRS AND TUNNELS:Types of Dams and bearing of Geology of site in their selection:

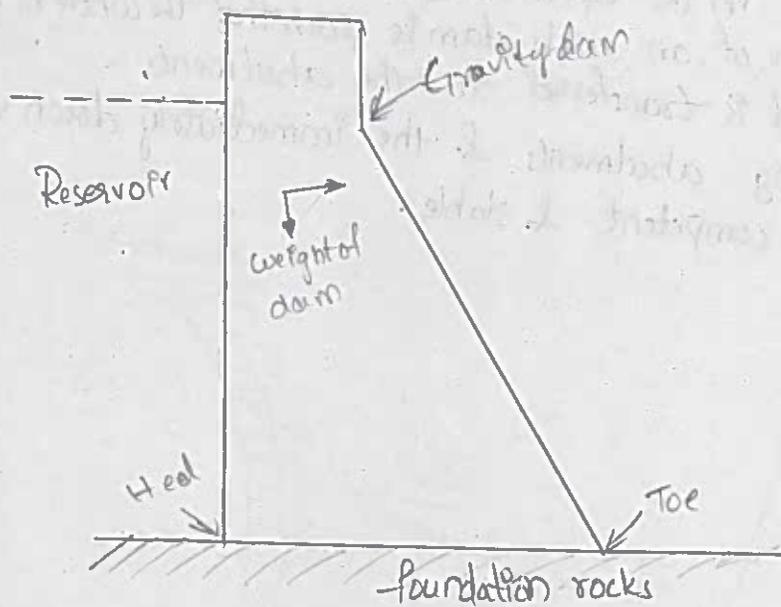
The role of geology in dam construction is multifaceted and includes crucial factors like the selection of the dam site and selection of the dam type.

Geological bearing is important in the selection of the dam type because different varieties of dams suit particular geological and topographical conditions.

Gravity Dams:

These dams are heavy and massive wall-like structure of concrete in which the whole weight acts vertically downwards.

∴ a dam of this nature is to be selected only in such places where very competent and stable rocks occur.



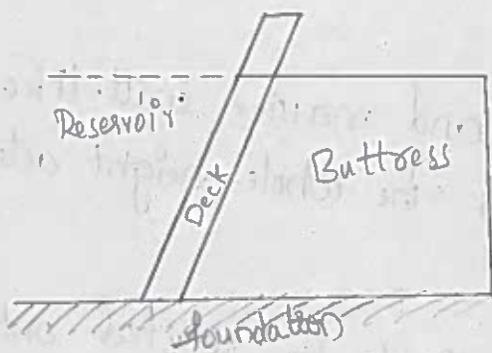
figs Gravity dam

## Buttress DAM:

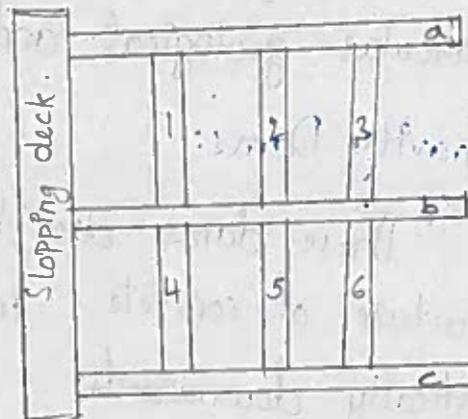
These are concrete structures in which there is a deck sloping upstream. This deck which takes entire load is supported from behind by walls called buttresses.

The foregoing design of a buttress dam facilitates the distribution of loads acting over a wide area covered by buttresses & struts.

This naturally means that even slightly weaker rocks can be considered as suitable for the construction of the dam.



figs. Side view of buttress dam

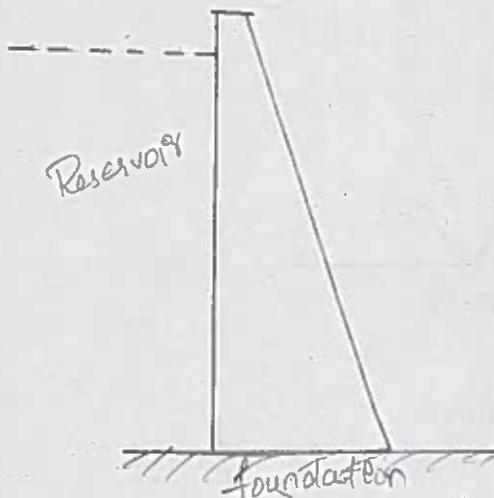


figs. Top view of buttress dam

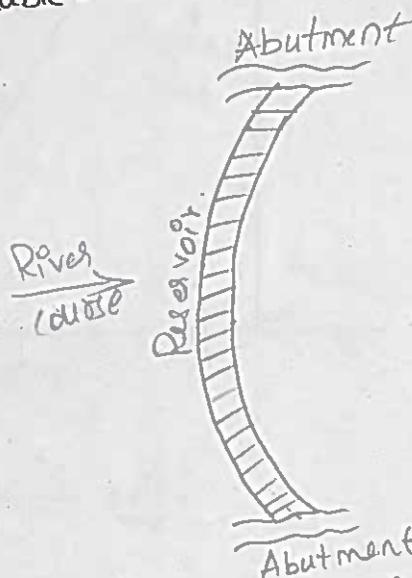
Arch Dam: This kind of dam is arch-shaped & is always convex in the upstream side.

The shape or design of an arch dam is such that the whole or greater part of the load is transferred to the abutments.

The rock-forming abutments & the immediately down valley should be very competent & stable.



figs. side view of arch dam



figs. Top view of arch dam

## Earth Dam:

The earth dams are trapezoidal in shape. when most of the material used in earth, it is called an earth-fill dam & if most of the material used in rock, it is called rock-fill dam.

The earth dams may be homogeneously impervious or may have impervious core.

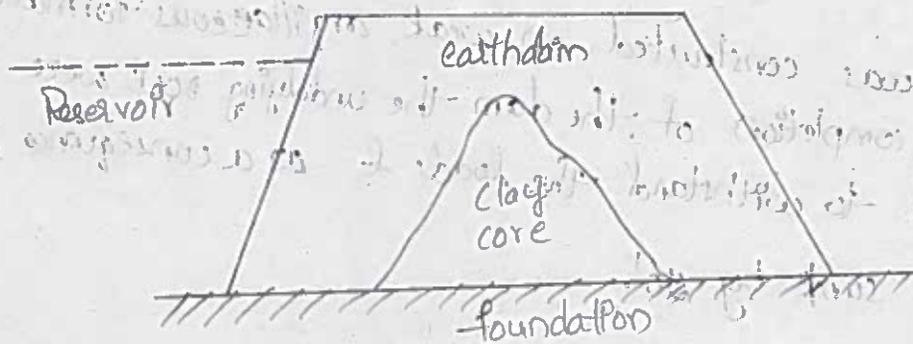


Fig: Earthdam

Case Histories of Dam failures due to Geological conditions  
St. Francis Dam of California:

This was a gravity dam having height of 90.5' & length of 700'. It was constructed on a composite foundation of schists and soft argillaceous conglomerates. In turn, were mutually separated by foundation schist a distinct fault.

⇒ Hales bar Dam on Tennessee River:

This dam was constructed over a cavernous limestones. Such rocks are naturally weak both physically and chemically. To improve the site conditions & to reduce the seepage, the large openings were filled up by using more than 3000 tons of cement & 1100 barrels of asphalt.

## Austin Dam on the Colorado River in Texas

This was a masonry dam of 68' height, 1090' length & 66' width.

This dam was built on faulted limestone interbedded with shales.

This means that both lithology & attitude of beds were undercutting undesirable at dam site.

## Lafayette Dam of California

This was constructed on weak argillaceous formations. After the completion of the dam the underlying rock were incompetent to withstand the loads & as a consequence, the dam had sunk by 20'.

## Geological Considerations in selection of Dam sites

The success of dam is not only related to its own safety & stability but also to the success of associated reservoirs.

Geological studies bring out the inherent advantages or disadvantages of site.

→ Narrow river valley

→ Occurrence of the bedrock at a shallow depth.

→ Competent rocks to offer a stable foundation.

→ Proper geological structures.

## Considerations of Reservoir:

- The Geological point of view, a reservoir can be claimed to be successful if it is watertight.
- It has a long life due to a very low rate of silting in the reservoir basin.
- It is needless to say that the reservoir basin should be of adequate capacity to hold a large & desirable quantity of water to derive optimum benefit.
- The reservoir, when filled, gives chance for reactivation of underlying inactive faults.

## Leakage - Tightness:

As a consequence of weathering, which is a natural process, the surface is covered by loose soil & below it lies the fractured rock. The bedrock which is massive occurs further below.

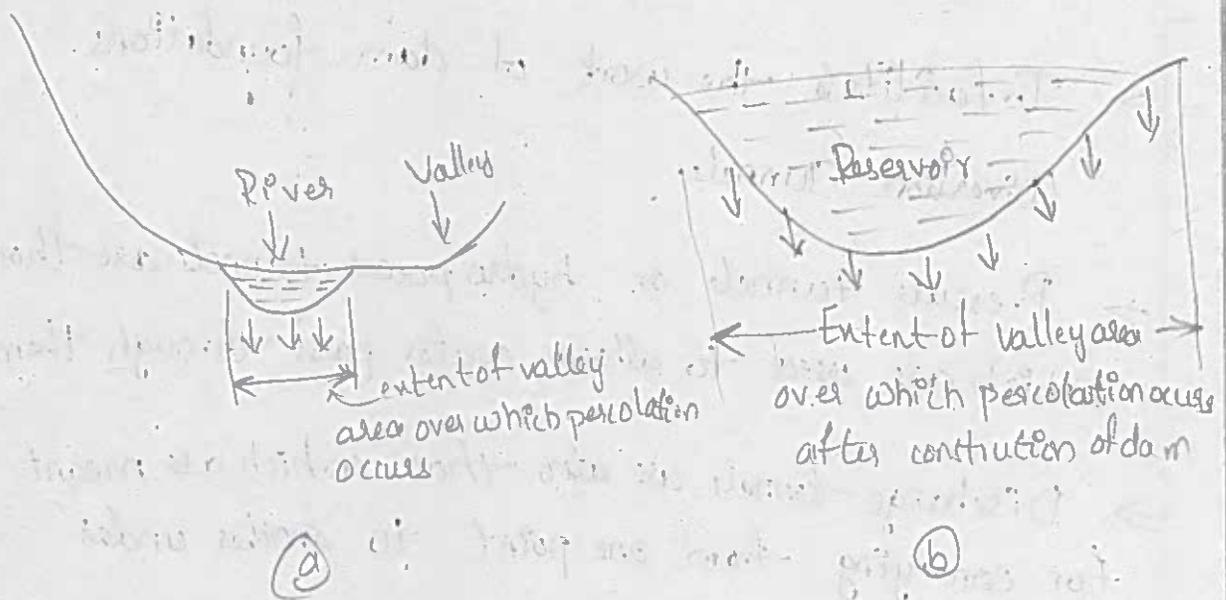


Fig: Percolation at reservoir side.

## Life of a Reservoir

- silting which commences at the bottom of the reservoir continues and the thickness of deposited sediments gradually increases with the passage of time.
- This process of silting correspondingly reduces the capacity of reservoir to store water.
- The river transports these sediments & dumps them ceaselessly in the reservoir.
- This process goes on & the capacity of the reservoir to hold water gradually vanishes & finally in the reservoir only sediments remain but no water.

## Purpose of Tunnelling:

- Tunnels are made to serve some specific purpose.
- Often, tunnels are excavated across hills or highlands to lay roads or railways.
- To facilitate the work of dam foundations (Diversion Tunnels).
- Pressure tunnels or hydro power tunnels are those which are used to allow water pass through them.
- Discharge tunnels are also those which are meant for conveying from one point to another under gravity force.
- Public utility tunnels.

## Effects of Tunnelling on the ground:

- The tunnelling process deteriorates the physical conditions of the ground. This happens because due to heavy & repeated blasting during excavations.
- Further, as a consequence of undergo tunnelling, the overlying rocks are deprived of support from the bottom, which means they are rendered unstable.
- Unstable conditions may also result when the beds involved are many, heterogeneous, & inclined along the tunnel.
- Fault zones & shear zones are naturally potentially weak, & tunnelling through them further deteriorates them & cause stability problems.
- Stability of ground may be jeopardized when the tunnelled ground has unfavourable ground water conditions.

## Lining of Tunnels:

- When tunnels are made through weak or loose or unconsolidated formations, they are provided with suitable lining for safety and stability.
- Lining refers to the support provided for the tunnel.
- Lining may be in the form of steel structures or concrete.
- The main purposes of lining are to resist the pressures from the surroundings & to protect the shape of the tunnel.
- Lining takes care of the weaknesses of the ground.
- It also helps in checking the leakage of ground water in to the tunnel.

Excavations through hard rocks necessarily involves the removal of some of the rocks outside the proposed perimeter of the tunnel.

The quantity of the rock broken and removed, in excess of what is required by perimeter of the proposed tunnel is known as overbreak.

- The nature of the rocks.
- The orientation and spacing of joints or weak zones in them.
- In the case of sedimentary rocks, the orientation of the bedding planes and thickness of beds with respect to the alignment of the tunnel.

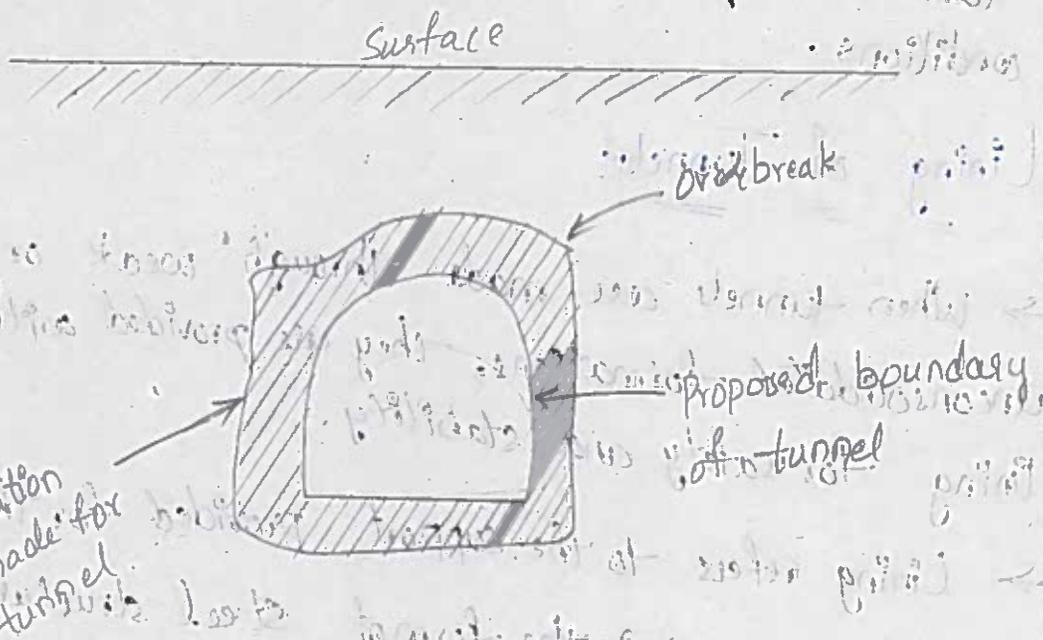


Fig. over-break in a tunnel

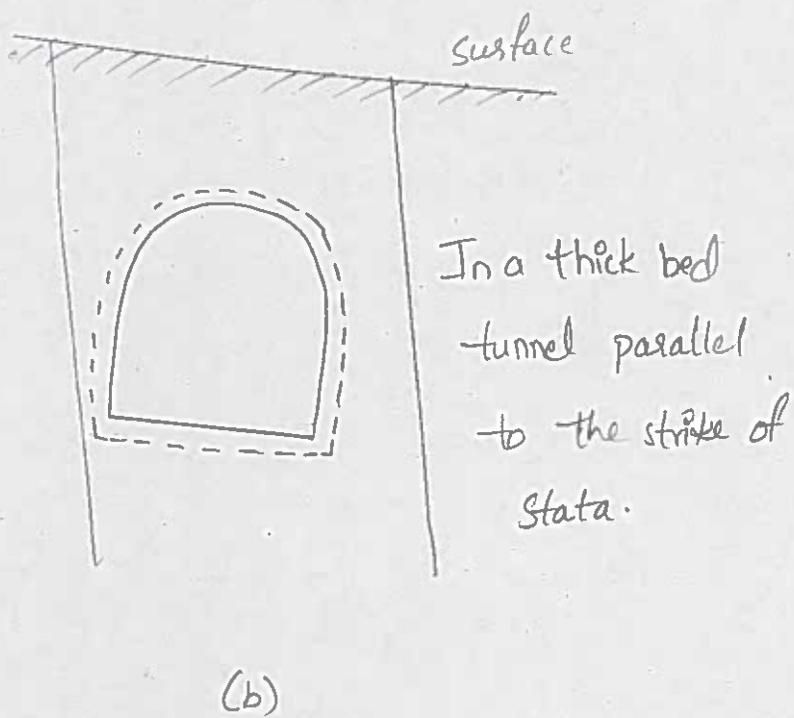
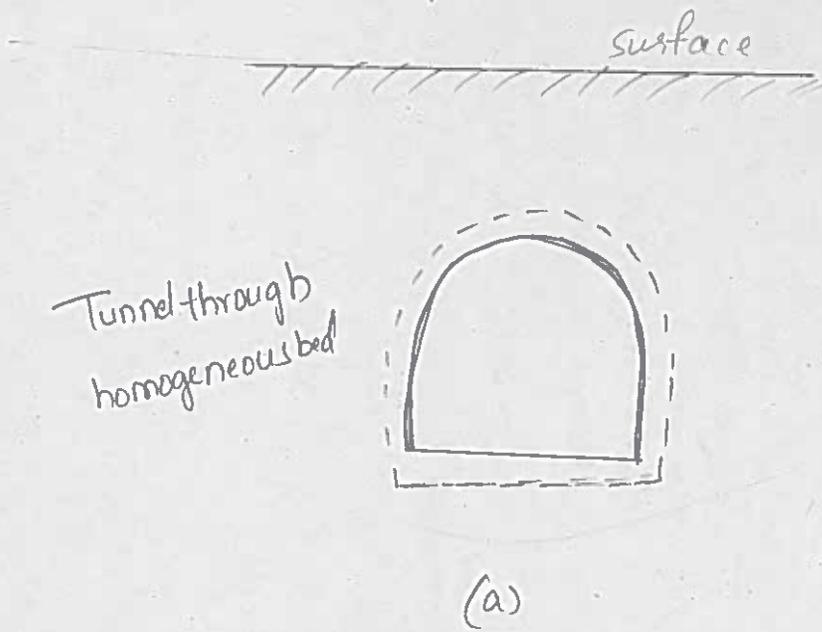


fig 3 (a & b) cases where overbreak occurs less