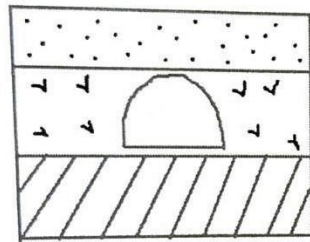


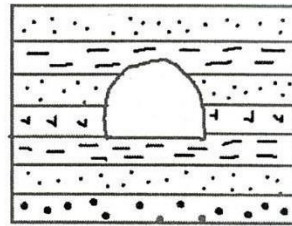
4.4 ENGINEERING IMPORTANCE OF FOLD, FAULT AND JOINTS

Tunnels:

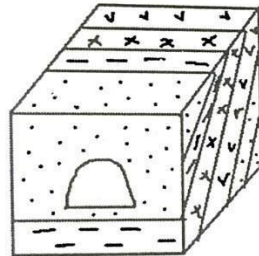
Tunnels are the underground passages or routes through hills, mountains or earth crust used for different purposes. These passages are made by excavating rocks below the surface or through the hills, mountains.



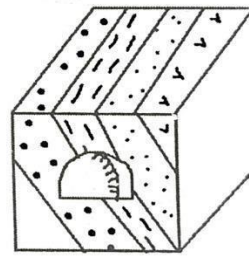
Safe Tunnel



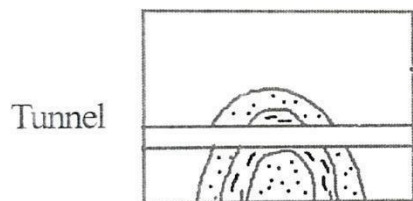
Unsafe Tunnel



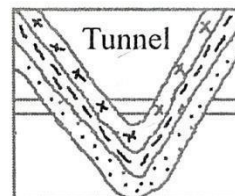
Tunnel parallel to dip direction - safe



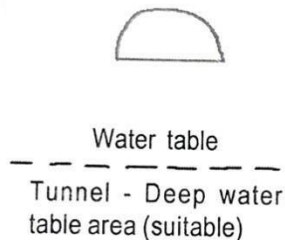
Tunnel parallel to strike - unsafe



Tunnel

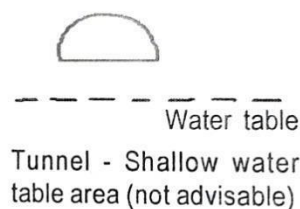


Tunnel in syncline - unsafe



Water table

Tunnel - Deep water table area (suitable)



Water table

Tunnel - Shallow water table area (not advisable)

Effect of tunneling on the ground:

- Deterioration of the physical conditions of the ground is the common effect of tunneling.
- This happens because due to heavy and repeated blasting during excavating, the rocks get shattered to a great extent and develop numerous cracks and fractures.

- This reduces the cohesiveness and compactness of rocks.
- At normal conditions the earth crust or underground rocks are under great pressure (overburden) or they will be in association with some geological structures like folding will be at equilibrium stress holding the prevailing strain intact.
- When the tunnel is created, such rocks which are at equilibrium gets disturbed resulting in the collapse of the roof. Frequent bursts may also occur.
- This phenomenon of fall of rocks in brittle and hard rock is called Popping. Due to tunnelling, the overlying Rocks deprive of support from the bottom and may become unstable.
- Such unstable conditions become still more precarious if the tunnelled beds are incompetent or loose or unconsolidated or saturated with ground water

Over break: During tunneling the excavations normally involve the removal of extra rocks or matter around the tunnel. The quantity of rock broken and removed, in excess of what is required by the perimeter of the proposed tunnel, is known as over break.

Factors governing the amount of over break: The nature of the rocks. Orientation and spacing of joints or weak zones in them.

In the case of sedimentary rocks, the orientation of the bedding planes

- Thickness of the beds with respect to the alignment of the tunnel.
- Geological factors influencing the over break: Massive and soft rocks of a homogenous nature cause less over break than harder rocks with well-developed joints or weak zones. In sedimentary rocks, thin formations and those with alternating hard and soft strata produce more over break. This is because, during excavation, softer rocks yield more than the hard rocks.

Roads:

The following are the structural factors to be considered in road alignment.

- i. Dip and strike
- ii. Joint
- iii. Faults

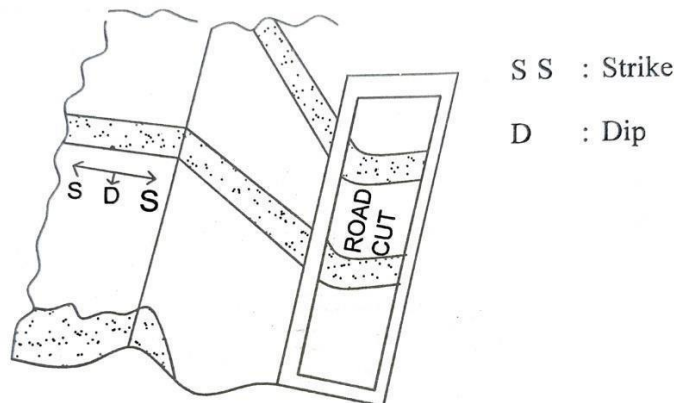
i. Dip and strike:

Three cases are considered under this factor.

a. Road cut parallel to dip direction:

In this case, the strata will offer a uniform behaviour on either side of road cut and hence the risk of failure is minimal in this case.

ROAD CUT PARALLEL TO DIP DIRECTION

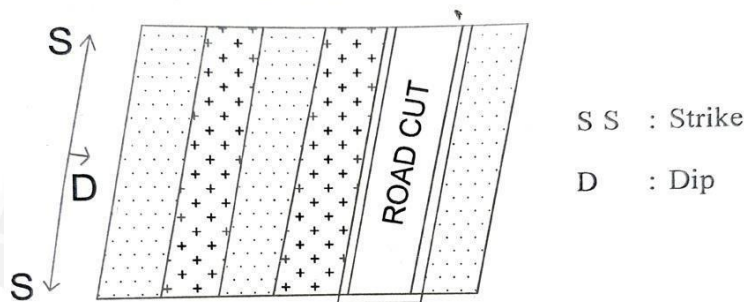


b. Road cut parallel to the strike:

1. Strata / layer plunge or dip inside the road cut:

In this case, when rocks are lubricated with rain water or ground water movement, there is likely to have slip or fall of materials.

ROAD CUT PARALLEL TO STRIKE



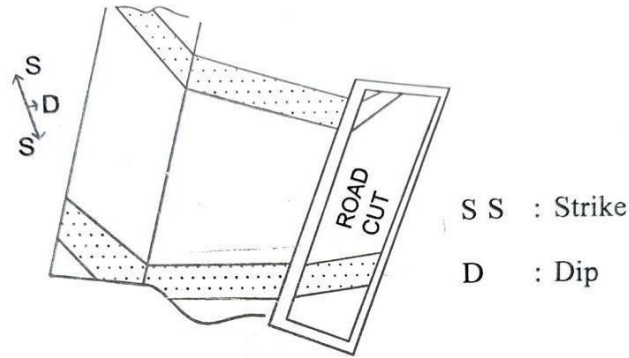
2. Strata dipping into the hill:

In this case, the slope of road cut will be unequal on both sides. This situation would result in similar difficulties as raised in cuts parallel to strike.

c. Road cut inclined to dip and strike:

In this case, the slope of road cut will be unequal on both sides. This situation would result in similar difficulties, as raised in cuts parallel to strike.

ROAD CUT INCLINED TO DIP AND STRIKE



When there is no alternative in the above two undesirable cases, slope stability measures, such as perfect retaining wall, efficient drainage system etc, have to be taken before initiating the project.

2. Weathering conditions:

When the strata under the road cut is composed of layers of heterogeneous nature with varying hardness, then weathering will lead to erode softer layers faster than harder ones, giving rise to undermining of the face. This will lead to rock fall or debris fall.

3. Groundwater conditions:

Groundwater due to its movement or other factors, lubricate the rock strata and reduce their bearing capacity.

Hence, the water table depth be should studied thoroughly in the proposed road site.

Dam:

A dam is a hydraulic structure constructed across a river to store water in the upstream side for various purposes like domestic water supply schemes, irrigation, hydro-power generation, etc.

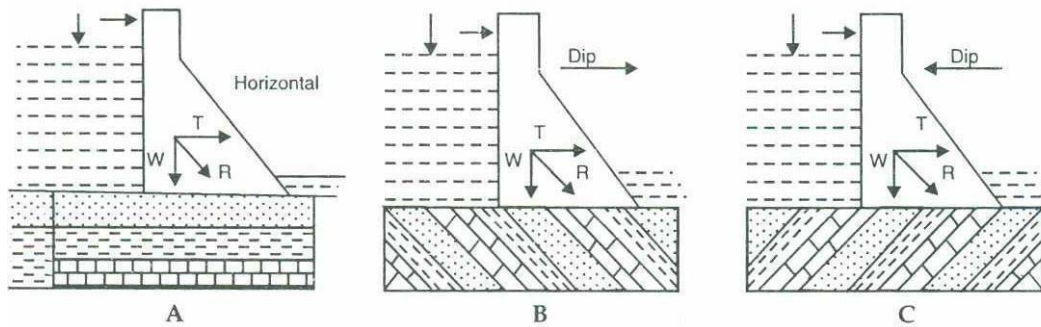
Dams on various Geological Strata:

The strength of sound, unfractured stratified rock is always greater when the stresses are acting normal to the bedding planes than if applied in other directions.

This being so, horizontal beds should offer best support for the weight of the

dam.

But as is shown in a latter section, the resultant force is always inclined downstream.



The most unfavourable strike direction is the one in which the beds strike parallel to the axis of the dam and the dip is downstream

It must be avoided as far as possible.

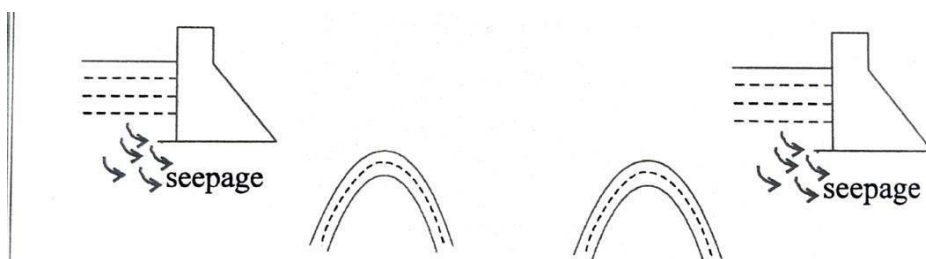
Therefore, other conditions being same, beds with upstream dips are quite favorable sites for dam foundations.

Dam in Anticlinal upstream and downstream sides

Fold – Favourable situations for civil engineering projects:

1. Dam along upstream side of anticline:

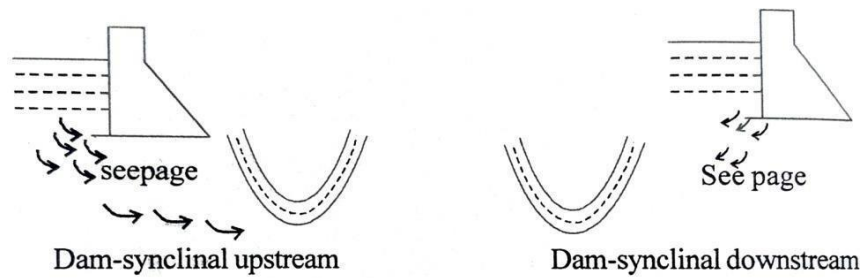
The upstream side of the anticline will be a favourable site for dam, because, seepage from reservoir, if any, will be along the upstream side of the anticline, i.e., within the reservoir side itself.



2. Dam along downstream side of syncline:

The downstream side of the syncline will be a favourable site for dam, because, seepage from reservoir, if any, will be along the downstream side of the syncline, i.e., within the reservoir side itself.

Folded strata are found favourable for accumulation of oil and natural gas.



Fold – Unfavourable situations for civil engineering projects:

1. The downstream side of anticline:

Unfavourable for dam project, because, there will be loss of water to reservoir, due to seepage towards the downstream side of the dam.

2. The upstream side of syncline:

Unfavourable for dam project, because, there will be loss of water to reservoir, due to seepage towards the downstream side of the syncline as well as dam.