USN | | | | | | | | | |

CMR INSTITUTE OF TECHNOLOGY, BENGALURU.
ACCREDITED WITH A+ GRADE BY NAAC

Internal Assesment Test - Dec2021

Sub:	ENGINEERING GEOLOGY					Sub Code:	18CV36	Branch:	CIVIL
Date:	27/ 01 / 2022	Duration:	90 min's	Max Marks:	50	Sem/Sec:	III		OBE

Answer All Questions

		MARKS	CO	RBT
1	What is fold? With neat diagram describe the parts and types of folds	[10]	CO3	L2
2	Define faults. With relevant sketch, explain parts and types of faults	[10]	CO3	L2
3	What are joints? Explain with a neat sketch different types of joints	[10]	CO3	L2
4	What is structural Geology? Explain the effect of folds and faults on the dam construction	[10]	CO3	L3
5	What is Coastal erosion? Explain the preventive measures of coastal erosion	[10]	CO3	L1

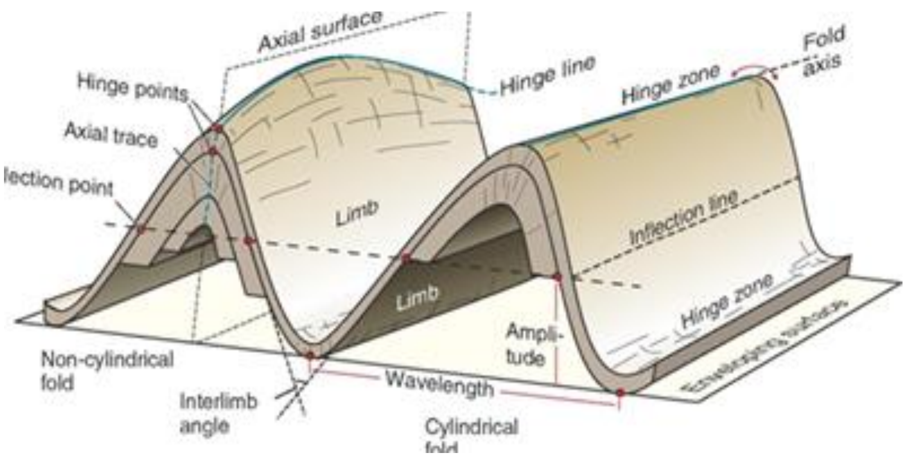
1. FOLDS

An undulation is obtained in rock strata produced by compressive forces in plastic strata similar to buckling of an overload column.

Folded strata is greatly strained broken and incompetent, therefore form weak and unsafe zones in construction areas especially excavation tunneling, hillside, cutting and dam, bridge site.

Anticline and other up folds form potential oil traps while synclines and other down fold form potential aquifer for groundwater. In some instances down folds like synclines when filled with groundwater artesian conditions undergoing pressure affecting the stability of the ground above and therefore the stability of structure constructed in such ground.

Parts of Fold:



Hinge: It is the area of maximum curvature.
Hinge line: It is the line of maximum curvature. The hinge line may be horizontal, nclined or vertical.
Crest: Elevated part of the fold or Anticline
Trough: Depressed part of the fold or Syncline
Wave length : Is the distance between crest or Trough
Axial plane: The imaginary plane which cuts a individual unit of fold in two halves
Limb(s): These are the areas between the hinges or in other words these are sides of the fold.
Interlimb angel: It is the angle between two limbs.

Flat lying homocline (180°), Gentle (170° – 180°), Open (90° - 170°), Tight (10° - 90°) Isoclinal (0° - 10°

Folds are classified depending on the upward and downward bending of rocks beds as below

Anticline: A simple up fold in which older beds lie inside and the limbs dip away from each other equally or unequally like the sides of a gable roof of a house. When the limbs dip equally the fold is called a symmetrical anticline when dip unequally, it is called asymmetrical anticline.

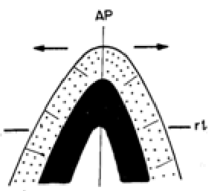


Fig. 8.4 Typical anticline (vertical)
AP: Axial plane rl : Right Limb LL : Left limb

Syncline: a Simple down fold in which younger beds lie inside and the limbs dip towards each other. When the limb dip equally the fold is called symmetrical synclines, when dip unequally an asymmetrical syncline.

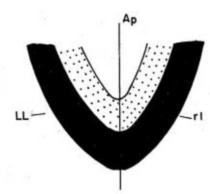
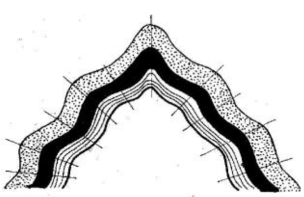


Fig. 8.5 A Typical Syncline AP : Axial Plane LL : Left Limb RL : Right Limit

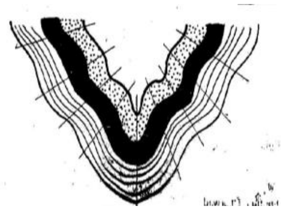
Anticlorium

A large Anticline with secondary folds smaller size developed on it



Synclorium

A large Syncline with secondary folds smaller size developed on it

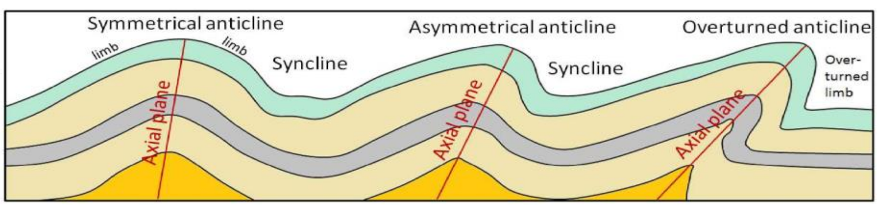


Folds are classified depending on the position of axial plane as below

Symmetrical Folds:
When the axial plane divides a fold into two equal halves in such a way that one half is the mirror image, then the fold is called as symmetrical fold.

Asymmetrical Folds :
When the axial plane divides a fold not of the in such a way that not having same magnitude (Inclined), asymmetrical folds are formed.

Overturned Folds :
Both limbs dip in same direction but one limb will be beyond vertical . The beds dip in the same direction on both sides of the axial plane because one of those limbs being rotated through an angle of at least 90º



FAULT

A fault is a fracture or fracture zone in rocks along which there has been displacement of the two sides relative to one another parallel to the fracture. A fault is defined as a displacement of rock strata, due to relative movement of adjacent blocks has taken place.

A fault is a rupture deformation produced either by tensional or compressive forces.

Causes and Mechanism of Faulting

Faults are produced from several causes

1). Tectonic Process: - involving forces operating within the crust of the earth.

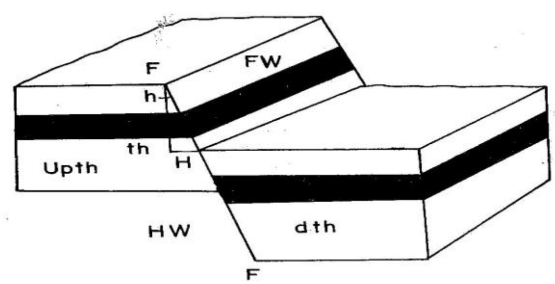
2). Non-Tectonic process: - involving gravity

Tectonic Process:
1). Horizontal tension- rocks fail under tension along near vertical fracture or along shear fracture dipping over 60^o.

2). Horizontal compression: - Rocks fail under compression along low angle fractures

3). Vertical movements: - associated with folding like arching or depressing the rock strata developing tensional forces by which the rocks fail by rupture with differential movements.
Non-Tectonic process cause rock deformation, landslide are more effective, a succession of slightly curved parallel fractures with characteristic displacement occur in rock bodies under certain conditions due to landslide slumping.

Parts of Fault:



1).Fault plane (FF): - The planar fracture surface along which the break and dislocation of rock beds have taken place.

The fault plane may be simple, clean cut smooth or open fracture or a an irregular zone of a number or smaller intersection fracture making a small angle with the main fault called a shear zone often filled with crushed rock and flour.

Shear zones range in width from less than a meter to several meters.

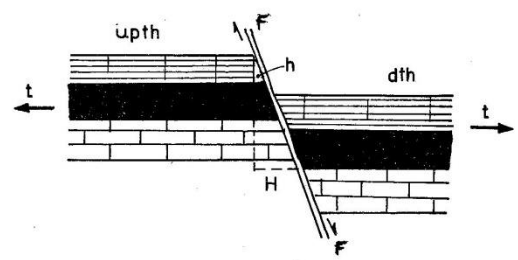
Fault plane may be vertical, but commonly it is steeply inclined. The attitude of the fault plane is specified by its dip and strike parameters. The intersection of fault plane with the surface is called the fault outcrop, fault line, fault strike or commonly fault trace.

The stable land mass at the displacement region is called the **footwall** and Unstable land mass or which is displaced is called **hanging wall.**

Throw: The vertical component of fault movement. The side of fault plane or trace, which appears to have moved down, ie the fault block above an inclined fault plane is called down, throw side.
The side that appears to have moved up relative to the down throw side is called the up throw side.
The amount of throw varies from a few centimeters to thousand of meters.

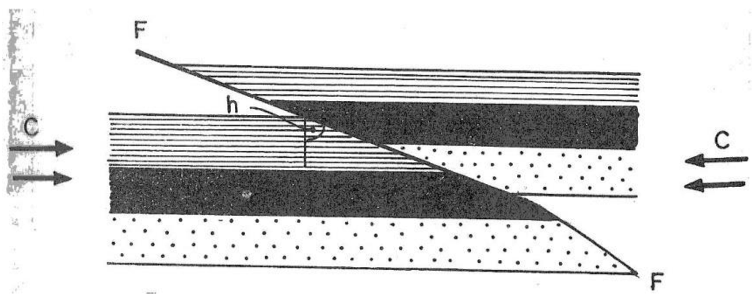
Heave: The horizontal component of the fault movement, t he shift in measured at right angles to the strike movement.

Hade: The angle between the inclined fault plane and the vertical. Hade is the compliment of the dip of the fault plane. Hade is measured from the vertical and is expressed in degree
Normal Fault: A normal fault is a high angle dip-slip fault in which the fault plane is inclined steeply with hade10 deg -20 deg or less. The vertical component of the movement ie the throw is generally large. The hanging wall moves downwards relative to the foot wall and caused by extensional tectonic forces. This kind of faulting will cause the faulted section of rock to lengthen.



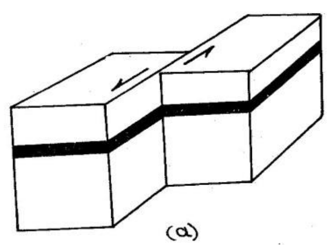
Reverse Fault: A reverse fault is a low –angle dip-slip fault in which the fault plane is inclined less steeply towards the up throw side i.e the hade is pointing towards the up throw side and the hanging wall has moved up relative to the foot wall and caused by compressional tectonic forces. This kind of faulting will cause the faulted section of rock to Shorten.

Reverse faults are produced by severe compressive forces and the fault planes commonly area gently dipping with large hade over 45 deg.. Reverse fault may be small, local or regional.

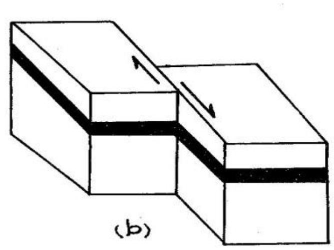


Lateral Fault: - A lateral fault is a strike slip fault i.e in which the dislocation is essentially horizontal in the direction of the strike of the fault plane without any dip-slip component. Lateral faults are also called faults, transverse, transcurrent or wrench faults. The fault plane is vertical of near vertical.

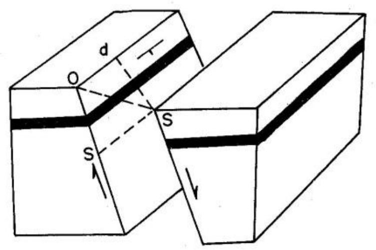
(a). Left-lateral or Sinistral Fault: - in which the left block appears to have moved towards the observer.



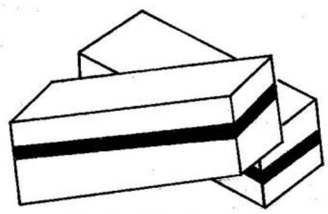
(b). Right-Lateral or Dextral Fault: - in which the right side block appears to have moved towards the observer.



slip and strike-slip components.



(d). Hinge-Fault: - A fault with an angular or rotational displacement in which the wall rocks of one side have rotated along an axis normal to the fault plane with respect to the rocks of the other wall.



Special kinds of Faults

Step Fault: - a fault system consisting of a number of faults all parallel to each other vertical or inclined in the same direction with repeated down throw sides also systematically in the same side resulting in the dislocated strata resembling steps of a **stair case**. Each step is a fault block and its top may be horizontal or tilted. **Step fault** is also called a **fault terrace.**

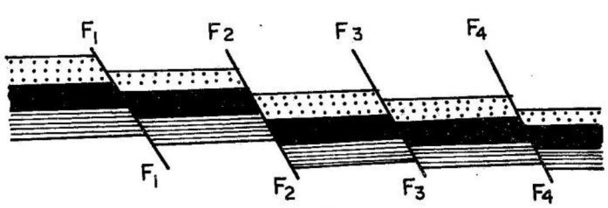
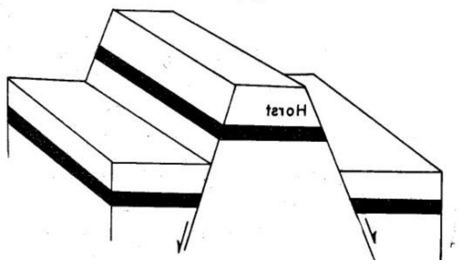
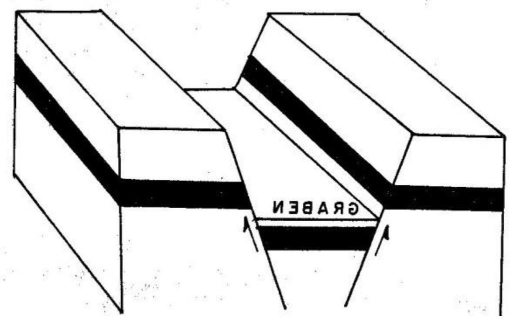


Fig. 9.12 A Step fault system

Horst Fault: A fault system consisting of a pair of normal faults whose fault planes are inclined away from each other with a common up throw side in between. The side of a ridge fault system forms a conspicuous inverted wedge shaped ridge parallel to the fault planes, generally long compared to its width called **ridge or a horst.**

Graben Fault: A fault system consisting of a pair of normal faults whose fault planes are inclined towards each other with a common down throw side in between. The down throw side of a troughs fault system forms a long trench or depression parallel to the fault planes, general long compared to its width called **fault basin or graben of a rift valley.**



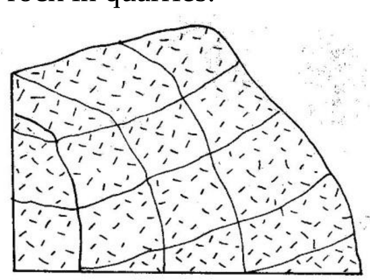


3. JOINTS

Joints are the cracks or fracture present in the rocks along where there has been no displacement along the cracks. These are natural divisional planes or fractures dissecting rock masses in patterns along which there has been no parallel movement of blocks of rocks. The joints are rupture deformation, but differ from fault in not accompanied by dislocation of blocks of rocks . Joints may be of any attitude, vertical, inclined or horizontal. Joints spacing varies widely from a few centimeters to several meters.

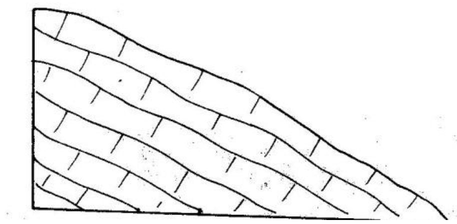
Mural Joints:

Mural joints consist of three almost equally spaced mutually perpendicular joint sets dissecting the rock mass into cubical blocks. These points are typical tension joints produced in the rock mass during cooling and solidification of magma . This system is typical noticed in granites and related massive plutonic and certain hypabyssal rocks. Mural joint system helps obtain easily intact cubical blocks of rock in quarries.



Sheet Joints:

This system, also typical of granite and other plutonic rocks, consists of one set of prominent joints parallel to the ground surface with varying spacing usually increasing with depth, and the other less marked at right angles. Sheet joints dissect the rock mass into sheet like blocks. These joints are produced by tensional forces due to relief from confining pressures and consequent unimpeded vertical expansion of the rock.



Columnar Joints:

This system is typical and certain other volcanic igneous rocks, and consists of vertical and horizontal cross joints dissect the rock mass into a number of vertical polygonal, usually hexagonal prismatic columns. These joints are produced during the cooling of horizontal flows of lava due to the development of weak planes by radial contraction around spaced centers in the cooling mass of lava. The lines joining these centers are directions of great tensile stress

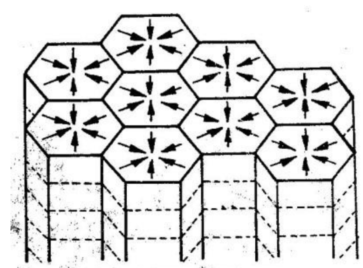


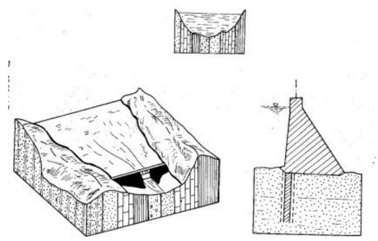
Fig. 10.4 Columnar jointing in basalt

When molten lava cools and solidifies enormous thermal contraction take place and the stress which accompanies the contraction develops a strain beyond the elastic limit of the solidified rock, its rigidity is overcome and series of more or less regularly space vertical cracks develop perpendicular to these directions. As the cracks advance they bound in between beautiful hexagonal prismatic columns of rock.

4. STRUCTURAL GEOLOGY

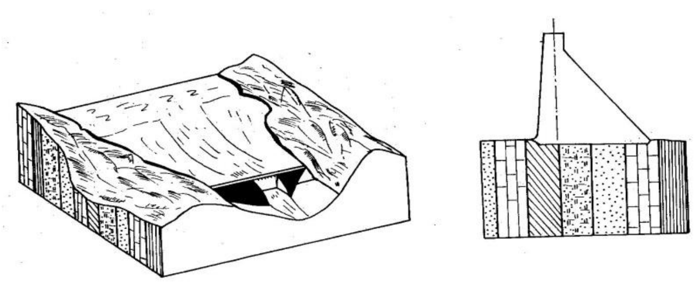
Structural geology, scientific discipline that is concerned with rock deformation on both a large and a small scale. It deals with the study of deformation structures like folds, faults, joints, rock cleavage. Deformation is any process that affects the shape, size, or volume of an area of the Earth's crust

Dams on Horizontal Beds: - Horizontal beds provide good and safe foundations offering best support for the dam wall taking the load safely as bedded rocks are stronger in compression. But the presence of open bedding planes, seams and joints complicates the conditions and pose problems by providing passages for percolation of water beneath the dam.



Dams on Vertical Beds: -Vertical beds in dam sites either parallel to or across the dam axis act as vertical sheet piles and take weight of the dam safely. Jointed vertical beds, however allow leakage through bedding and joint plains, from the reservoir beneath the

dam when they are parallel to the river course with detrimental effects on dam stability. In case of sites with a series of vertical beds, the dam structure would be safe if it is positioned with its heel resting on a thick intact impermeable bed as this acts as natural cut off wall.



Dam across anticline dip valley: - In this case there is a choice between a site on upstream dipping limb and a site on downstream dipping limb and a site on downstream dipping limb

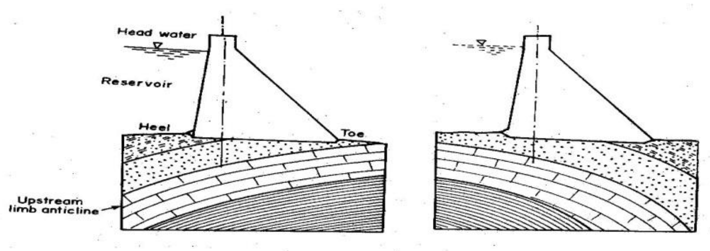
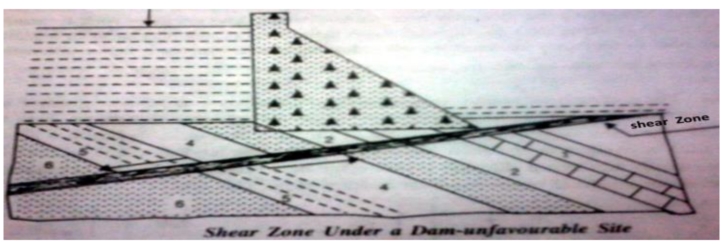


Fig. 13.35. Dam across anticlinal dip valleys.
Sita A : Dam on upstream dipping limb.
Site B : Dam on downstream dipping limb

Dam across the Faults

Faults are most dangerous geological structures and are capable of completely destroy on any civil engineering structure . occurrence of faulting irrespective of its dip and strike at the dam site is most undesirable. If the fault zone is crushed or intensely fractured , it becomes physically incompetent to with stand the forces of the dam. Movement of the rocks along the fault zone damaging the foundation of the dam. 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.



5. Coastal erosion

Coastal erosion is the wearing away of land or the removal of beach or dune sediments by wave

action, currents and tide. It is a dynamic and often complex process it can be cyclical with periodic episodes of coastal retreat and rebuilding.
Beaches are eroded when they lose more sediment along shore, offshore than they receive from various sources.
In order to prevent coastal erosion, rigid protection methods are usually used throughout the world. 4. Erosion is controlled by engineering method with the help of the geology.

Jetty: A Jetty is any of a variety of structures used in river, dock, and maritime works that are generally carried out in pairs from river banks, or in continuation of river channels at their outlets into deep ocean water . This is also a hard structure stabilization. It helps in avoiding build up of unwanted sediments by collecting sand on one side of it before it reaches the structure. Seawall A seawall is a hard structure constructed parallel to the coastline that reduce the effects of strong waves and to defend the coast around a town from sea erosion

Groins: Groins are impermeable structures that fingerlike, perpendicularly to the shore which extend from backshore into the littoral zone. This type of structure is easy to construct from a variety of materials such as wood, rock or concrete, steel, bamboo (Timber) and normally used on sandy coasts.

Revetments: Revetments are another type of hard structure of stone, concrete built parallel to the sea or at the front of a beach to protect the slope against wave or current–induced erosion. Beach Nourishment Beach nourishment is one of the most popular soft engineering techniques of coastal defense management schemes. Mainly, Beach Nourishment is the addition of sand and sediment to a beach to replace sand and sediment that has been eroded away. It involves the transport of the “nourishment material” from one area to the affected areas. The replacement sand is usually dredged up offshore and transported to the beach. Offshore sand is almost always much finer grained and muddier, therefore it erodes very quickly.

Sand dune: Stabilization Mainly, coastal sand dune are of vital importance in providing natural protection to beaches and backshore areas from infrequent severe storms. Another way is Vegetation: it can be used to encourage dune growth by trapping and stabilizing blown sand.