First year of Geomatics Department

Engineering Geology 2018

Lecture 9

SURFACE DAMS

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BASED ON PURPOSE

- **Storage Dam**
- **Detention Dam**
- **Diversion Dam.**
- **Coffer Dam**

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1. STORAGE DAM

- it is constructed to create a reservoir to store water during periods when there is huge flow in the river (in excess of demand) for utilization later during periods of low flow.
- Water stored in the reservoir is used for irrigation, power generation, water supply etc.

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2. DETENTION DAM

- It is primarily constructed to temporarily detain all or part of the flood water in a river and to gradually release the stored water later at controlled rates
- So that the entire region on the downstream side of the dam is protected from possible damage due to floods.
- - It may also be used as a storage dam.

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3. DIVERSION DAM

- It is constructed to divert part of or all the water from a river into a conduit or a channel.

- For diverting water from a river into an irrigation canal, mostly a diversion weir is constructed across the river

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4. COFFER DAM

- It is a temporary dam constructed to exclude water from a specific area.
- It is constructed on the u/s side of the site where a dam is to be constructed so that the site is dry.
- In this case, it behaves like a diversion dam.

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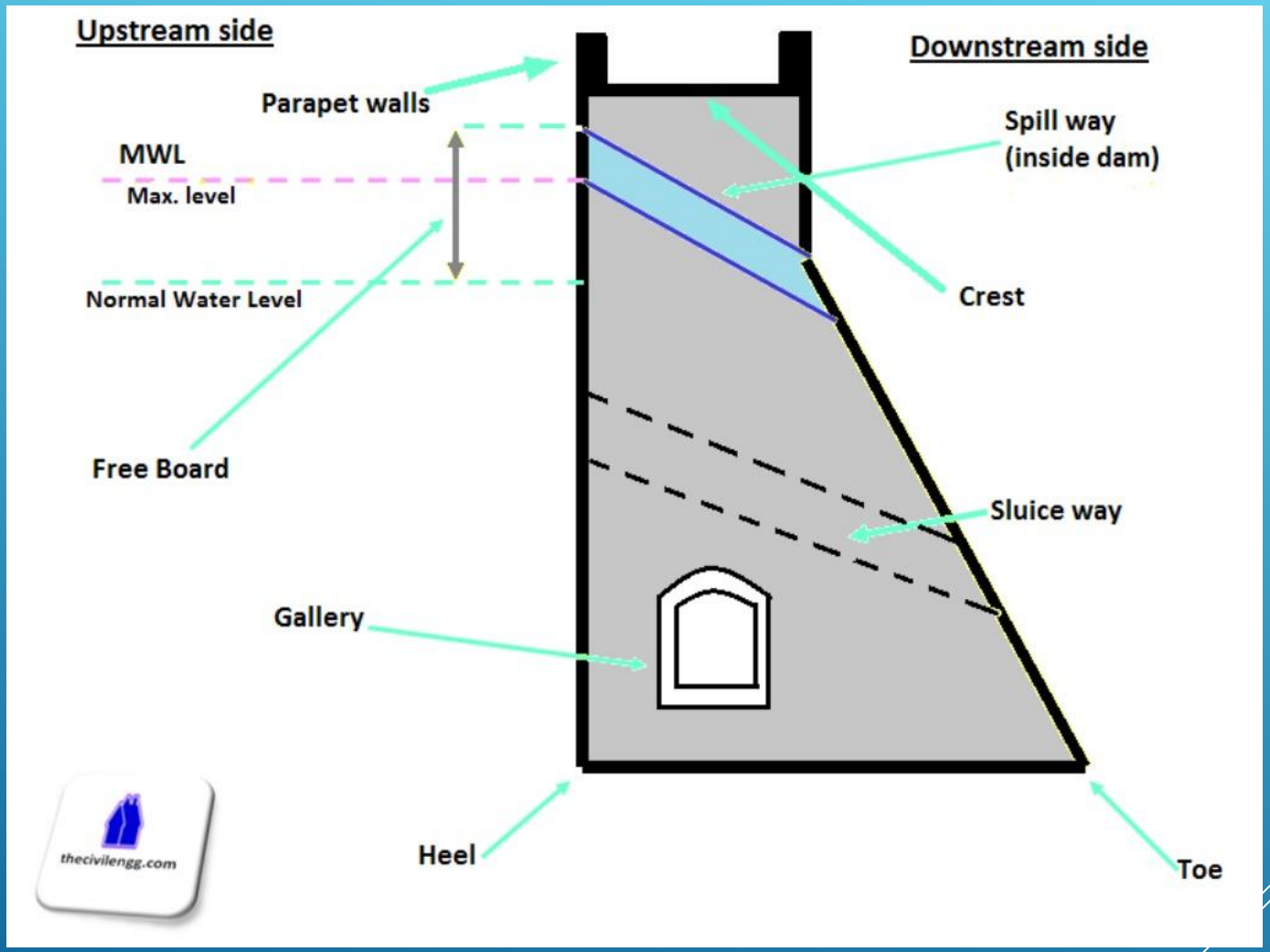
DAM TYPICAL PARTS



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DEFINITIONS

- A typical dam has following parts:
- **Crest:** The top of the dam. In some cases, this provides a roadway or walkway.
- **Parapet walls:** Low protective walls on either side of the roadway on the crest.
- **Abutments:** The valley slopes on either side of the dam wall to which it is keyed.
- **Freeboard:** The space between the highest level of water in the reservoir and crest of the dam.

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DEFINITIONS

- A typical dam has following parts:
- **Heel**: The upstream portion of the dam in contact with the river bed or foundations.
- **Toe**: The downstream portion of the dam wall for the discharge of surplus water from the reservoir.
- **Spillway**: The passage in the darn wall for the discharge of the surplus of water from the reservoir.
- **Gallery**: Level or gently sloping tunnel-like passage transverse or longitudinal within the dam wall with drains in the floor for seepage water

BASED ON STRUCTURAL BEHAVIOR

- **Gravity Dam**
- **Arch Dam**
- **Buttress Dam.**
- **Embankment Dam**

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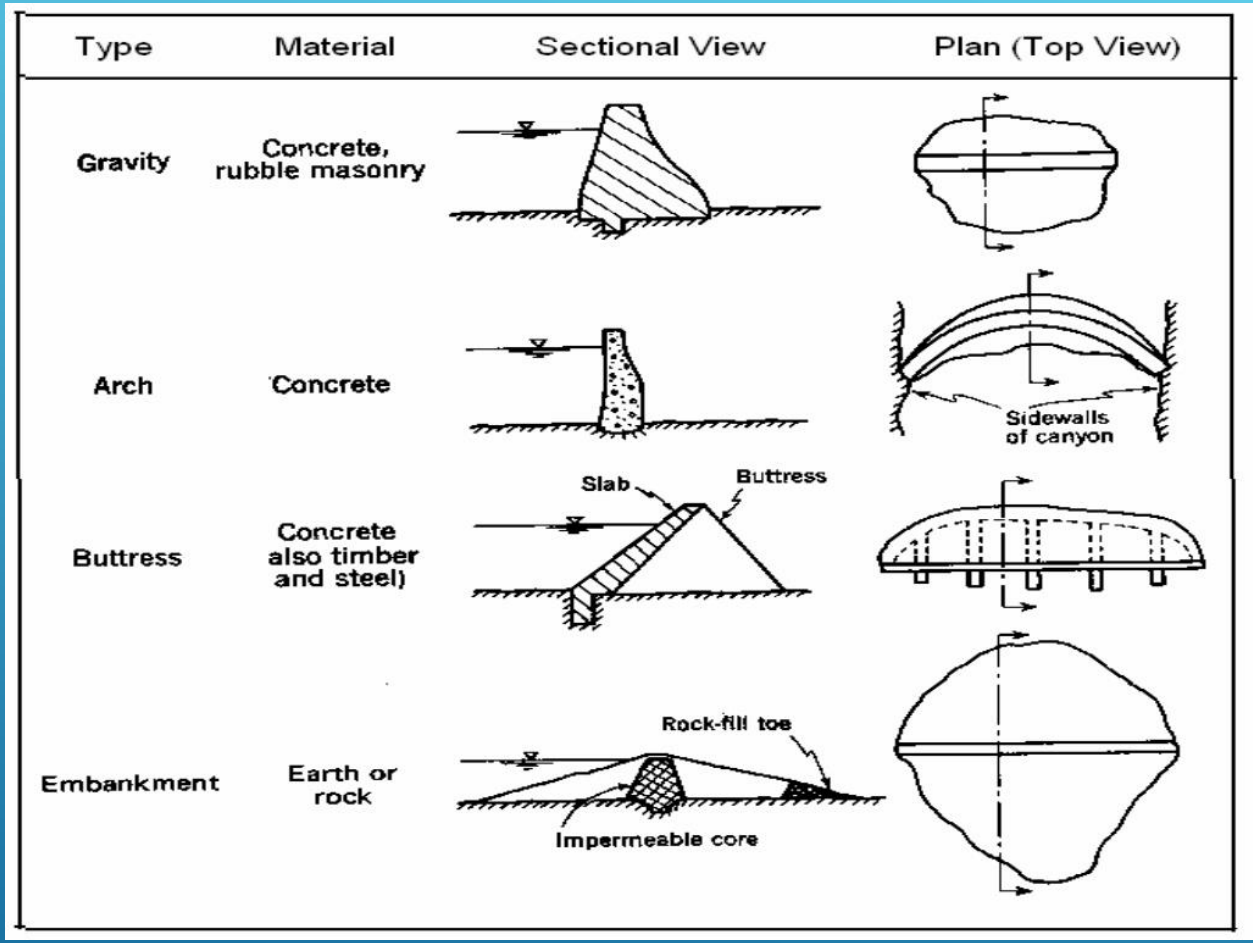
DAM TYPICAL PARTS



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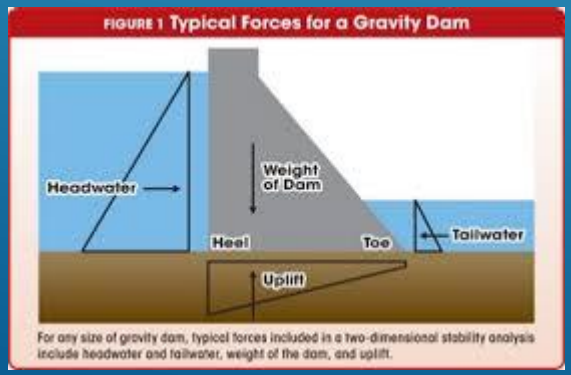
1. GRAVITY DAM

- The entire force acting on dam wall is transmitted on to small area of the foundation.
- Therefore, a dam of this nature is to be selected only in such places where very competent and stable rocks occur.



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2. ARCH DAM

- The shape & design of the arch is such that the whole or the greater part of the load is transferred to the abutments.
- This means the rock below the abutments should be competent and stable. The modulus of Elasticity of rock should be high enough.
- Arch Dams are best suited to narrow, deep, river-cut gorges.

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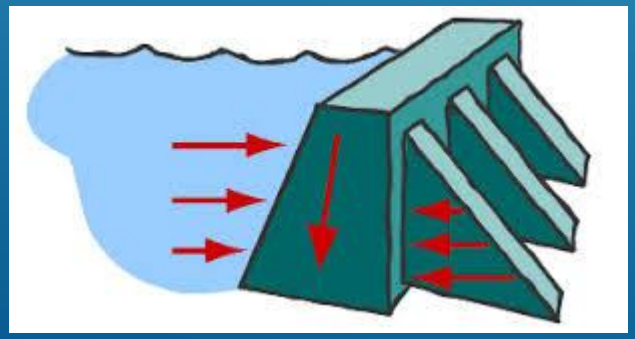
3. BUTTRESS DAM

- These are concrete dams in which there is deck sloping upstream. This deck which takes entire load is supported by buttress which are further supported by struts. The buttress distribute the loads over a wide area.
- Thus, an even slightly weaker rocks can be considered as suitable for this kind of dam.



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4. EMBANKMENT DAM

- Earth dams are planned in such places where the underlying material is too weak to support masonry dams or where competent rocks occur at greater depths. They are built of clay, sand, gravel etc.,
- Due to the greater area of base & some other factors, the weight exerted by dam per unit area of ground will be relatively less.
- Thus, an even slightly weaker rocks can be considered as suitable for this kind of dam.

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GEOLOGICAL CONSIDERATIONS IN THE SELECTION OF DAM SITE

- Narrow River Valley
- Occurrence of Bedrock at a shallow Depths
- Competent rocks to offer Stable Foundations

1. Suitability of different types of rocks
2. Influence of weathering
3. Effect of occurrence of intrusions
4. Effect of fracturing

- Effect of Associated Geological Structures
- Leakage below Dams

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NARROW RIVER VALLEY

- At proposed dam site, if the river valley is narrow, a small dam is required which reduces the cost of construction.
- A Few defects at narrow river valley are as follows

1. Narrowing of valley due to landslides, rock creep, rock fracturing, thick superficial deposits such as residual soil, talus, boulders, silt and clay etc.,
2. The occurrence of buried river channels crossing the site, either below or adjacent to river bed.
3. Unsuitability of rocks due to presence of soluble minerals like gypsum or due to faulting which may be concealed beneath sediments.

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OCCURRENCE OF BEDROCK AT A SHALLOW DEPTH

- Shallower bedrock aims lesser foundation cost
- Bedrock occurs at shallow depths in young rivers since the sediments deposited in less. The problems with younger formation is as follows:

1. This hilly terrains may not provide a suitable topography for larger reservoir basin
2. The flow of water may not be high, therefore only small dams can be constructed

- To know the depth of bedrock geophysical investigations has to be carried out.

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DIFFERENT COMMON ROCKS &THEIR COMPETENCY TO OFFER STABLE FOUNDATIONS

Igneous Rocks

- The massive plutonic igneous rocks are most desirable at the dam site
- Volcanic rocks which have vesicular & amygdaloidal are not desirable.
- Massive basalts which are fine grained are desirable at dam site when they don’t have vesicular structure.

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DIFFERENT COMMON ROCKS &THEIR COMPETENCY TO OFFER STABLE FOUNDATIONS

Sedimentary Rocks

- Shales have slippery base hence undesirable at the dam site
- Well Cemented siliceous and ferruginous sandstones are competent and suitable for dam foundation
- Laterites, limestone & conglomerates are undesirable.
- Thick massive sedimentary formations with less porosity are desirable.
- Alternating soft and hard rocks of small thickness are undesirable.

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DIFFERENT COMMON ROCKS &THEIR COMPETENCY TO OFFER STABLE FOUNDATIONS

Metamorphic Rocks

- Gneiss unless they posses high degree of foliation and mica minerals is suitable at a dam site.
- Schist are undesirable
- Quartzite are very hard and highly resistant to weathering. They are neither porous, nor permeable.
- Marbles even tough compact by virtue of their chemical composition they are unsuitable at dam site.
- Slates are undesirable as it is soft, weak and have a slaty cleavage.

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SELECTION OF THE DAM SITE

The selection of dam site across a river is to impound water behind the dam.

Following points are required:

1. Topographically, a place which is most suitable for the purpose is selected. Ideally it should be narrow or a small valley with enough catchment areas available behind so that when a dam is placed there it would be easily store a calculated volume of water in reservoir created upstream.
2. Technically, the site should be as sound possible, strong, impermeable and stable. Strong rocks for design, impermeable for inventory of stored water and stability with references to seismic failures.

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DAM TYPICAL PLACES

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SELECTION OF THE DAM SITE

Following points are required:

3. Constructional, the site should not be far from deposits of materials which would be required for construction.
4. Economically, the benefits arising out of a dam is proposed to be placed at a particular site should be realistic and justified in terms of land irrigated , power generated and water stored.

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GEOLOGICAL INVESTIGATIONS FOR SELECTION OF THE DAM SITE

Following geological characters of the area should be investigated for particular site selected for dam. Geology of area comprising of main topographical features, natural drainage patterns, general characters and structures of rock formations, the trend and type of weathering and erosion of area.

- Geology of site i.e. types of rocks of the area where dam will be built, properties of rocks i.e. chemical composition, texture and hardness of rocks, porosity and permeability of rocks.
- Structural features of the rock i.c. dip, strikes, outcrop etc. Structural defect of rocks i.e. folds, fissures, faults etc.
- Crushing and shearing strength of rocks, extent of weathering of rocks.
- Thickness of the bedding planes.
- Zones of fractures and weaknesses.
- Water table in the area.

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STAGES OF PRELIMINARY INVESTIGATION IN SELECTION OF DAM SITE

- lithology: It provides details of rock type present, their nature and extent of weathering, occurrence of rock and soil debris etc., in that area
- Structure: It provides information on strike, dip of beds and also details of folds, faults, joints and unconformities.
- Topography: It provides information on surface features like valley, hills, trend of river, stability of slope, scope for occurrence of landslide. The rough assessment of depth of bed rock
- Ground Water Conditions: It provides information on springs, seepages, wells etc., which provides information on scope for leakage and present of any cavities.

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RESERVOIR

- A reservoir usually means an enlarged natural or artificial lake, storage pond or impoundment created using a dam to store water.
- Reservoirs can be created by controlling a stream that drains an existing body of water.
- They can also be constructed in river valleys using a darn.

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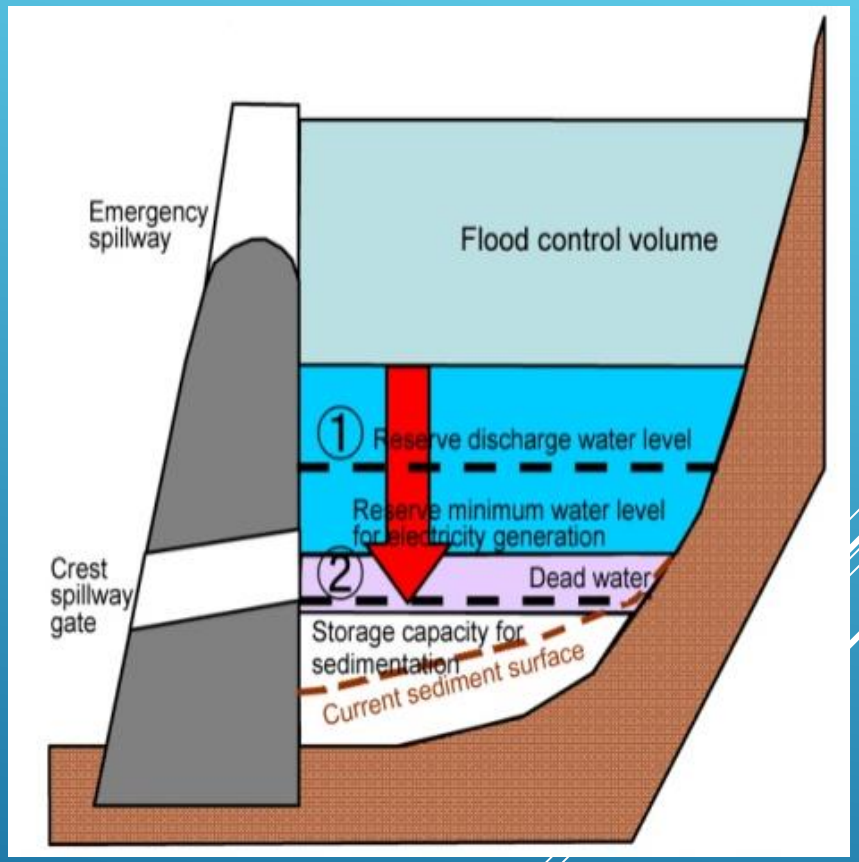
RESERVOIR PURPOSES

- Reservoirs may be managed to balance some or all of the following activities:

1. Water supply
2. Flood control
3. Soil erosion
4. Environmental management
5. Hydroelectric power generation
6. Navigation
7. Irrigation



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CONSIDERATIONS FOR SUCCESSFUL RESERVOIR

- From the Geological point of view, a reservoir can be claimed to be successful if it is watertight (i.e.. If it does not suffer from any serious leakage of water) and if it has a long life due to very slow rate of silting in the reservoir basin.
- The reservoir, when filled, gives chances for reactivation of underlying inactive faults. This in turn, gives scope for the occurrence of seismicity and landslides in that region.
- The Success of Reservoir depend on following factors:

1. Capacity of Reservoir
2. Effect of evaporation
3. Water tightness and influencing factor
4. Buried River Channels
5. Influence of Rock Types , Geological Structures, and Influence of Water Table

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INFLUENCE OF ROCK TYPES (IGNEOUS ROCKS)

- Intrusive igneous rocks like granite, by virtue of their composition, texture and mode of formation are neither porous nor permeable. Hence their occurs at the reservoir site will not cause leakage of water unless they have other defects like joints, faults, or shear zones.
- But the extrusive (i.e.. Volcanic) igneous rocks like basalt are not desirable because they are often vesicular.

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INFLUENCE OF ROCK TYPES (SEDIMENTARY ROCKS)

- By Virtue of their wide areal extent and frequency of occurrence, sedimentary rocks are the more important I this regard than igneous rocks. Among the different sedimentary rocks shale's are the most abundant followed by sandstone & limestone.
- Shale's the extremely fine grained sedimentary rocks. Are highly porous but not permeable. For this reason, the occurrence of shale's at the reservoir site shall not cause any leakage. Of course, at the dam site, its occurrence is considered undesirable because of its incompetency and slippery character.

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INFLUENCE OF ROCK TYPES (SEDIMENTARY ROCKS)

- The Sandstone is an aquifer and hence it has a tendency to cause leakage. However, careful examination is needed to know whether it causes severe leakage or not, if present at the reservoir site. This is so because the porosity and permeability of different sandstone differ depending on a degree of cementation and composition of the cementing materials of sandstones.
- The Occurrence of limestone, at the reservoir site is, in general, undesirable. Of course, it may not only have negligible porosity but also possess reasonable hardness and durability. Thus through the compact of massive limestone superficially seem to be water proof, they may be internally cavernous and cause profuse leakage.

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INFLUENCE OF ROCK TYPES (METAMORPHIC ROCKS)

- Gneiss, which is one of the most common metamorphic rocks, behave like granite, i.e.. They are neither porous nor permeable.
- The schist's, on the other hand, by virtue of their excellent foliation and soft and cleavage-bearing mineral content and a source of weakness and it leakage problems.

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INFLUENCE OF ROCK TYPES (METAMORPHIC ROCKS)

- The quartzite which are compact, by virtue of their quartz content and granulose structure, are neither porous nor permeable. Therefore, their occurrence at reservoir sites contribute to water-tightness.
- Marbles, through compact, by virtue of their calcium carbonate composition and calcite content are not reliable in terms of their water tightness.
- Slates due to their characteristics slaty due to their characteristic slaty cleavage may tend to cause leakage but their very fine grained nature helps in checking such leakage considerably.

THANKS

Please visit the following links:

https://en.wikipedia.org/wiki/Dam

https://www.britannica.com/technology/dam-engineering

https://www.youtube.com/watch?v=gihU4_Cmzko

https://www.youtube.com/watch?v=Cwq7wvnx2nE

https://www.youtube.com/watch?v=I7g3cnAVrC8

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