2018 Advanced Topics in Hydraulics and Hydrological Sciences for RA-II

ASSIGNMENT

On

Option "B"

Dams Situated in North India : Primary Uses, Biggest Challenges and Failure of Dams

By

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Introduction: In this assignment deals with a report on the important dams in North India. The topics covered are definition, the primary uses, challenges, reasons for dam failures and Dam Safety Initiatives - DRIP etc.

Definition: A Dam is defined as a barrier constructed across a river or natural water course for the purpose of:

(a) Impounding water or creating reservoir;
(b) Diverting water there from into a conduit or channel;
(c) Creating a head which can be used for generation of power;
(d) Improving river navigability;
(e) Retention of debris;
(f) Flood control;
(g) Domestic, municipal and industrial uses;
(h) Preservation of wild life and pisciculture;
(i) Recreation; etc

According to the National Inventory of Dams, the criteria for hydrologically significant dams includes any artificial barrier which impounds or diverts water and meets any of the following criteria: 25 feet or higher with a storage of at least 15acre-feet, or a height of six feet with a storage of 50 acre-feet or more.

Types of Dams:

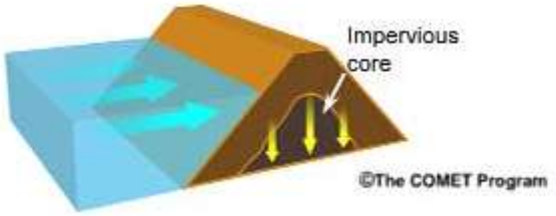
Dams may either be human-built or result from natural phenomena, such as landslides or glacial deposition. The majority of dams are human structures normally constructed of earthfill or concrete. Naturally occurring lakes may also be modified by adding a spillway to allow for safe, efficient release of excess water from the resulting reservoir. The main types are:-

1. Embankment Dams:-Earth fills or Rock fills

2. Concrete Dams:-Gravity, Buttress, Arch

3. Rubber Dams

1. Embankment Dams: Embankment dams are the most common type of dam in use today. Materials used for embankment dams include natural soil or rock, or waste materials obtained from mining or milling operations. An embankment dam is termed an “earthfill” or "rockfill" dam depending on whether it is comprised of compacted earth or mostly compacted or dumped rock.

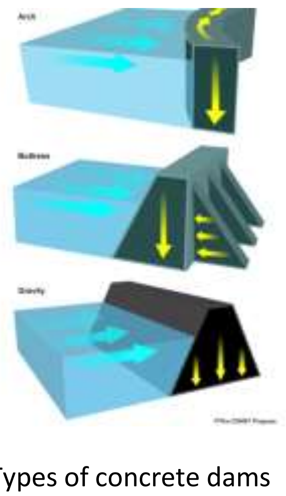


2. Concrete Dams: Concrete dams may be categorized according to the designs used to resist the stress due to reservoir water pressure. Three common types of concrete dams are: gravity, buttress and arch.

Gravity: Concrete gravity dams are the most common form of concrete dam. The mass weight of concrete and friction resist the reservoir water pressure. Gravity dams are constructed of vertical blocks of concrete with flexible seals in the joints between the blocks.

Buttress: A buttress dam is a specific type of gravity dam in which the large mass of concrete is reduced, and the forces are diverted to the dam foundation through vertical or sloping buttresses.

Arch: The arch may be curved in the vertical plane as well. Such dams are usually constructed of a series of thin vertical blocks that are keyed together; barriers to stop water from flowing are provided between blocks. Variations of arch dams include multi-arch dams in which more than one curved section is used, and arch-gravity dams which combine some features of the two types of dams.

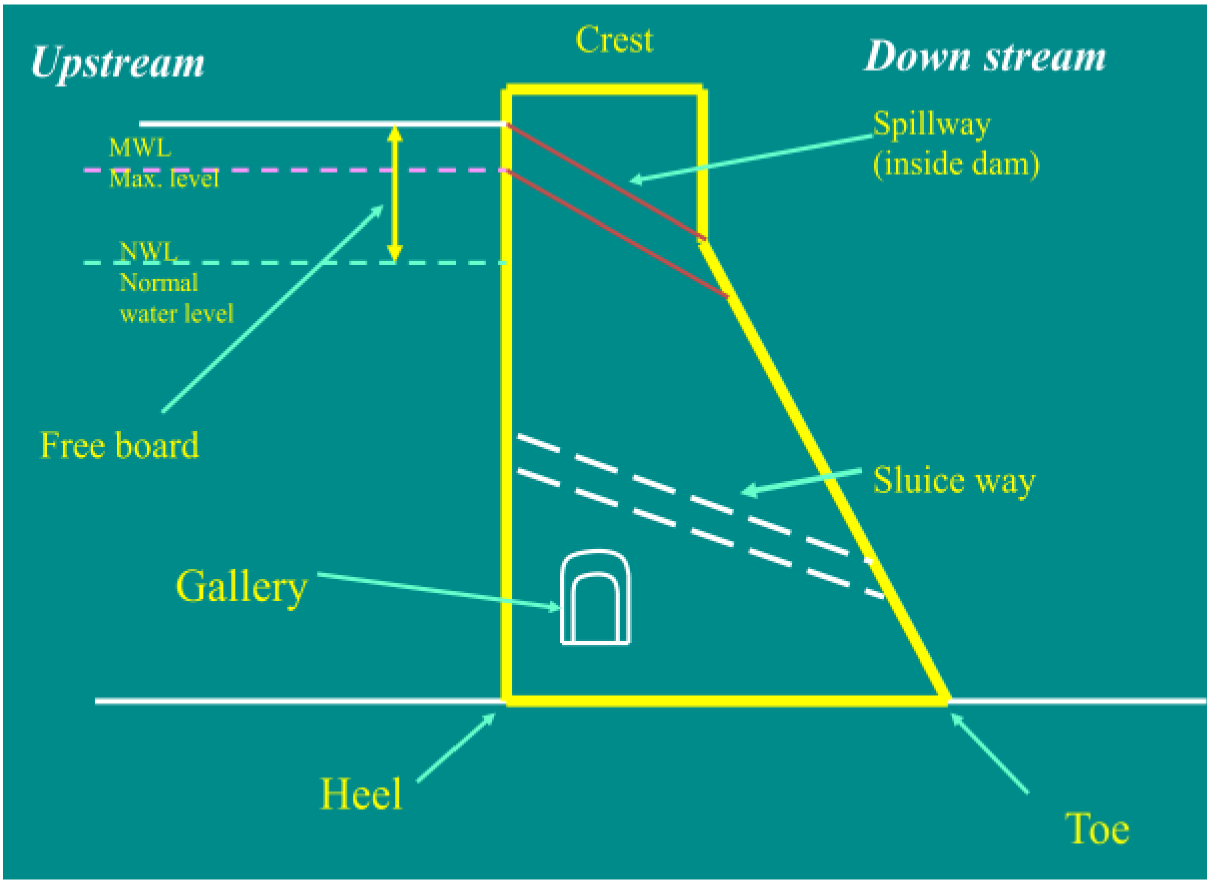


Types of concrete dams

3. Rubber **Dams**: The Rubber dam is relatively recent technological break-through. These are placed across channel, stream and weir crest to increase the upstream water level when inflated and because of that rubber dams are also called as inflatable dams. The dams are tubes which are made of rubberized material.

Dam owners should be aware of: the different types of dams , essential components of a dam, how the components function, and important physical conditions likely to affect a dam. Human-built dams may be classified according to the type of construction materials used, the methods used in construction, their slope or cross-section, the way they resist the forces of the water pressure behind them, the means of controlling seepage, and occasionally, their purpose. The components of a typical dam are illustrated in Figure .1. Nearly all dams possess the features shown or variations of those features

Structure of a Dam



Important Dams in North India:

Sl. No.	Name of the Dam	Location	Type of Dam	Comple-tion Year	Primary Use
1.	**Bhakra Dam**	Bilaspur, Himachal Pradesh	Earthen / Gravity & Masonry	1963	Hydroelectric, Irrigation, Recreation
2.	**Nathpa Jhakri (Sjvnl) Dam**	Kinnaur, Himachal Pradesh	Earthen / Gravity & Masonry	2008	Hydroelectric
3.	**Bhimtal Dam**	Nainital, Uttarakhand	Gravity & Masonry	1883	Irrigation
4.	**Dhauliganga Dam**	Pithoragarh, Uttarakhand	Rockfill		Hydroelectric
5.	**Tehri Dam**	Tehri Garhwal, Uttarakhand	Earthen / Gravity & Masonry	2005	Hydroelectric,Irrigation
6.	**Ranjit Sagar Dam**	Kathua, Punjab	Earthen	1999	Flood Control,Hydroelectric,Irrigation
7.	**Ranapratap Sagar Dam**	Chittaurgarh, Rajasthan	Gravity & Masonry	1970	Hydroelectric,Irrigation
8.	**Nanaksagar Dam**	Bhakra , Punjab	Earthen / Gravity & Masonry	1962	Irrigation
9.	Tigra Dam	Sank, Madhya Pradesh	masonry	1917	Drinking water supply

Failure of Dams:

Dams differ from all other major civil engineering structures in a number of important issues. The issues are:

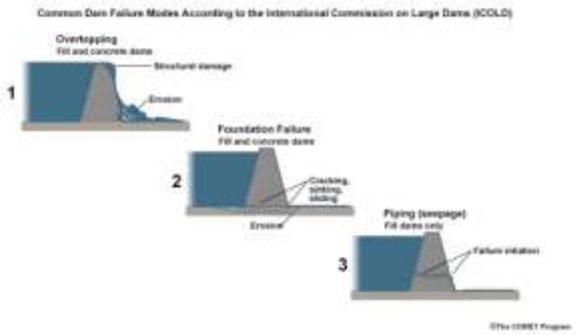
- Every dam, large or small, is quite unique; foundation geology, material characteristics, catchment flood hydrology etc. are each site-specific.

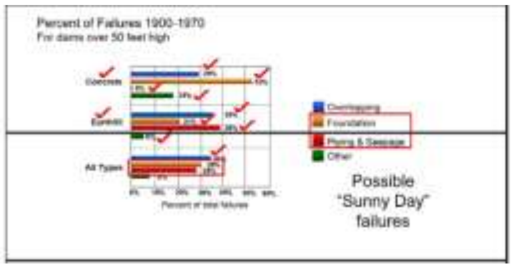
- Dams are required to function at or close to their design loading for extended periods.

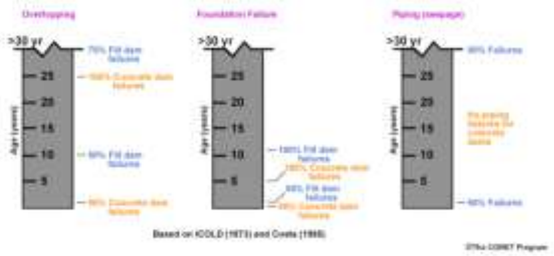
- Dams do not have a structural lifespan; they may, however, have a notional life for accounting purposes, or a functional lifespan dictated by reservoir sedimentation.

- The overwhelming majority of dams are of earthfill, constructed from a range of natural soils; these are the least consistent of construction materials.

- Dam engineering draws together a range of disciplines, e.g. structural and fluid mechanics, geology and geotechnics, flood hydrology and hydraulics.







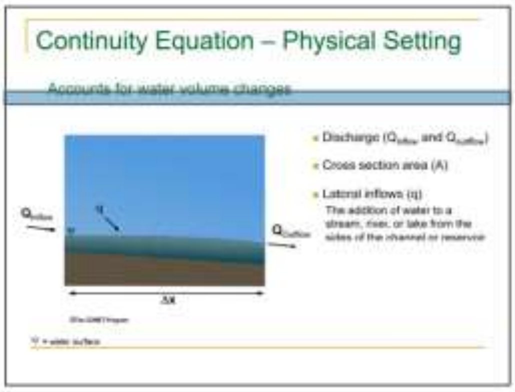
Failure cases of Dams in North India:

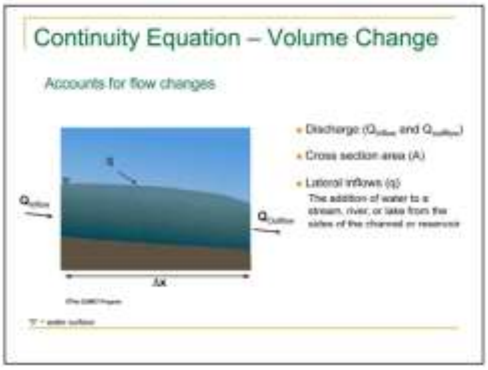
Nanaksagar Dam, Punjab, India Situated in Punjab in north-western India, the dam was constructed in 1962 at Bhakra. An estimated maximum discharge of 9,711 m^3/s had occurred on August 27, 1967, due to heavy monsoon rains that were heaviest in twenty years. This caused dam to fail. The water that gushed through the leakage created a 7.6 m breach, which later widened to 45.7 m. The condition of the reservoir had worsened, causing a 16.8 m boil downstream of toe, which was responsible for the settlement of the embankment. As the dam was overtopped, causing a breach 150 m wide. A downstream filter blanket and relief wells were provided near the toe but were insufficient to control the seepage.

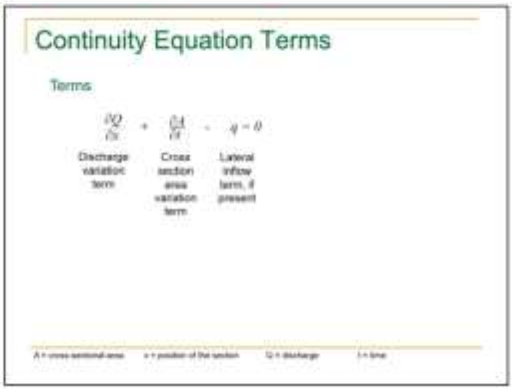
Tigra Damsituated Sank, Madhya Pradesh, India, constructed in 1917 . This was a hand placed masonry (in time mortar) gravity dam of 24 m height, constructed for the purpose of water supply. A depth of 0.85 m of water overtopped the dam over a length of 400 m. This was equivalent to an overflow of 850 m^3/s. Two major blocks were bodily pushed away. The failure was due to sliding. The dam was reconstructed in 1929.

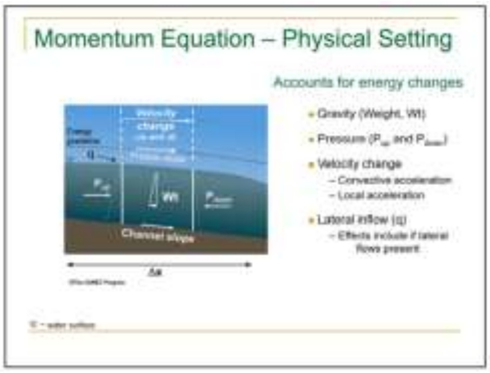
Modelling : St. Venant Equations, Modeling can be used in dynamic flow simulation, and dam failure contingency planning.

These equations are the basis of dam failure and flood wave modelling and most any type of dynamic flow simulation. Modelling assumes a one-dimensional gradually varied flow in open channels. This means computing the average cross-section water depth at any point along the river. Specifically, the continuity equation is based on the principle of conservation of mass while the momentum equation describes the equilibrium of forces within a body of water. Such forces include: hydrostatic pressure, convective and local accelerations, gravity, and friction.









Biggest Challenges:

According to the South Asia Network on Dams, Rivers and People (SANDRP) and other sources, in India, 5,500 minor and major dams built since independence have together displaced an estimated 55 million people and submerged 44,00,000 hectares of land . Nearly 47% of people displaced by these dams are tribals. Whenever a dam construction is announced in a particular area, it leads lot of people clueless and anxious. The oustees or the Project affected persons (PAPs) or displaced persons (DPs) suffer on various counts especially social, economic, deep psychological anxiety, cultural, and spiritual deprivation to name a few. A large unaccounted and involuntarily displaced people (IDPs) also get affected as after-effects of such announcements or commencements of such projects. Recently, pending Land Acquisition Bill is creating chaos amongst political parties as well as farmers. Assessing the socio-economic parameters affecting the individual pre and post Resettlement and Rehabilitation (R&R) is also a big challenge.

It is understood that even after many years of such projects, the oustees still wait for a fair compensation. The NGO working for the rights of Bhakra Dam oustees since the announcement of Bhakra pact on July 7, 1948, reveals that 36,000 families had lost their homes and land to the project. The Himachal Pradesh Government came out with rehabilitation and resettlement policy that provided for "land for land" and that too has not been implemented. As on date, the problem is still unresolved.

Dam Safety Initiatives – DRIP:

As part of continuous strengthening of the dam safety management in India, Government of India has taken up the Dam Rehabilitation and Improvement Project (DRIP) with World Bank assistance at an estimated cost of Rs. 2100.00 Crore. The project development objectives of DRIP are to:

- ❖ Improve the safety and performance of selected existing dams and associated appurtenances in a sustainable manner, and
- ❖ Strengthen the dam safety institutional setup in participating States as well as at Central level.

The objectives of DRIP are to be achieved through investments for physical and technological dam improvements, managerial upgrading of dam operations, management and maintenance, with accompanying institutional reforms. The project will thus address dam system management in a holistic manner.

The DRIP was taken up for implementation initially in 4 States (namely Kerala, Madhya Pradesh, Orissa, and Tamil Nadu) and in Central Water Commission (CWC). Karnataka has joined the DRIP in November 2014 as a fifth state for rehabilitation of their dams. Recently Uttarakhand Jal Vidyut Nigam Limited and Damodar Valley Corporation have also joined the DRIP .

With a view of exploring the available technologies that may support engineering, social, environmental and managerial interventions for dam safety, the Central Project Management Unit of DRIP has organised a Buyers-Sellers-Meet focusing on DRIP at Pragati Maidan, New Delhi, as a Side Event of the India Water Week -2016.

Points emerged in this meet are :

- Emergency Action Plans needed to be developed for all large dams in line with the ‘Guidelines for Developing Emergency Action Plans for Dams’ published by the CWC and implemented.

- Structural safety of the dams is required to be assessed at regular intervals preferably using latest available technologies such as geophysical methods, modern dam instrumentation etc. State-of-the-art Finite Element Method tools may be utilized to arrive at better understanding of the dam distress conditions to seek appropriate remedial measures.

- Flushing operations may be carried out twice in a year for reservoirs of the river valley projects for better sediment management as well as optimal power generation.

- Institutional set up of State Dam Safety Organisations to be strengthened to enable them for better monitoring of dams in their jurisdiction and for providing technical assistance to the dam owners.

- To implement the dam safety programme in a systematic and sustained manner across all basins, more DRIP like programmes may be initiated for providing technical and managerial assistance to the dam owners and also offering financial support through different means.

Summary of the main points in the report:

- Dam owners should be aware of: the different types of dams , essential components of a dam, how the components function, and important physical conditions likely to affect a dam.

- Dam engineering draws together a range of disciplines, e.g. structural and fluid mechanics, geology and geotechnics, flood hydrology and hydraulics.

- **St. Venant Equations, Modeling can be used in dynamic flow simulation, and dam failure contingency planning.**

- **Points emerged in the meet** Buyers-Sellers-Meet focusing on DRIP to be kept in mind for Dam safety.

References:

Course modules of "2018 Advanced Topics in Hydraulics and Hydrological Sciences for RA-II"(Dam Failure Concepts and Modeling) Module 1: Terminology and Open Channel Hydraulics" and Module 2: St. Venant Equations, Modelling and Case Study .