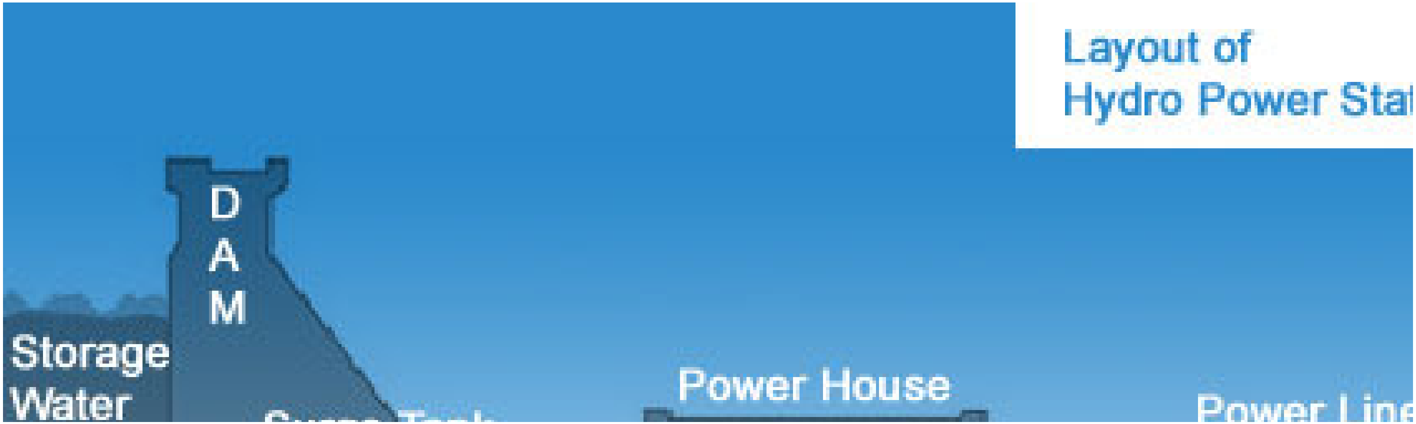
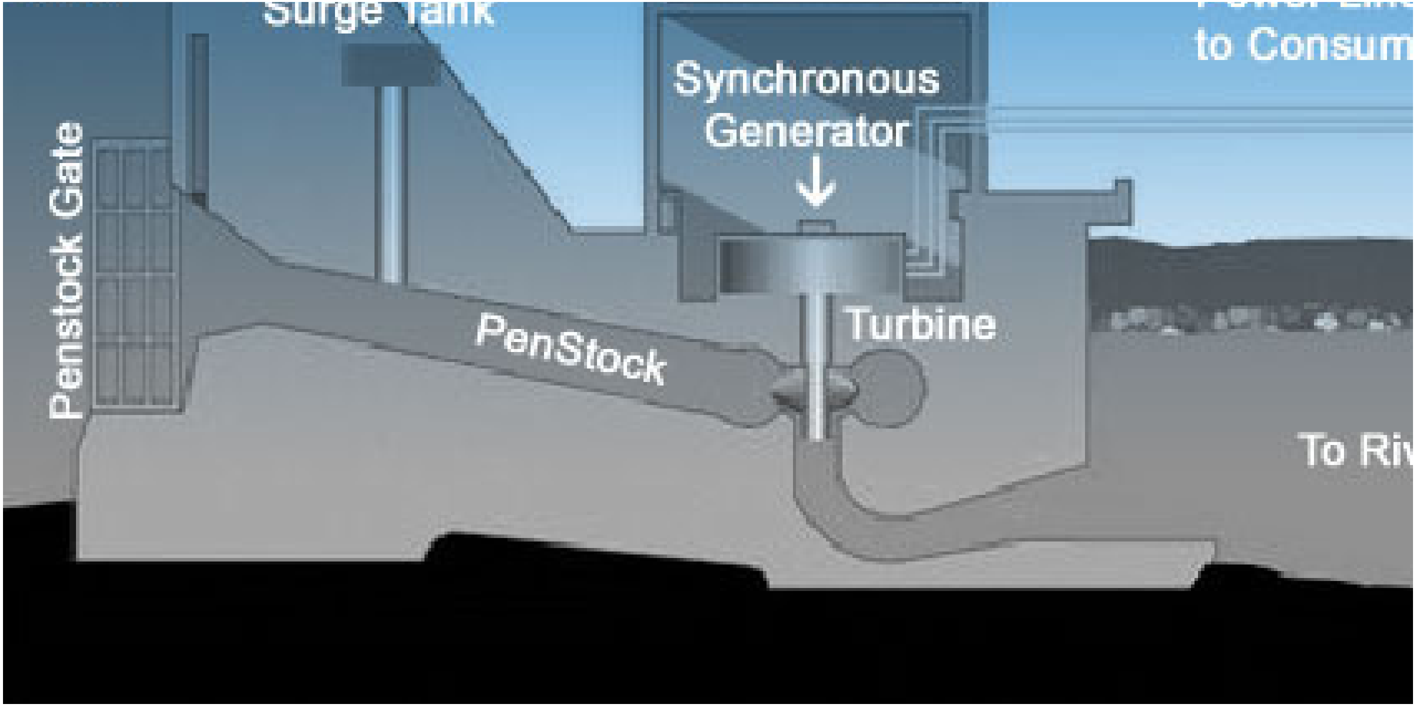
Hydro Power

A generating station which utilizes the potential of energy of water at a high level for the generation of electrical; energy is known as hydroelectric station. Hydropower is energy that comes from the force of moving water. The head of water fall and movement of water in the form of kinetic or potential is called as Water cycle or Hydropower cycle. Kinetic energy of water is energy motion and is function of mass and velocity while potential energy is function of the differences in level of water between two points. Prior to the widespread availability of commercial electric power, hydropower was used for irrigation, and operation of various machines, such as watermills, textile machines, sawmills, dock cranes, and domestic lifts. A Hydro- electric power station is used to supply electrical energy to consumers where water resources available.

Mainly the Hydro Power is depends on the rain. The rain defined as, energy from the sun evaporates water in the earth's oceans and rivers and draws it upward as water vapor. When the water vapor reaches the cooler air in the atmosphere, it condenses and forms clouds. The moisture eventually falls to the earth as rain or snow, replenishing the water in the oceans and rivers. The storage of rainy water is completely used for year or more than a year. The hydro power is depends on the power requirement can be defined as Base load station and Peak load station. In Base load station the load requirement is constant through out the year and cost of the power/unit is comparatively less. In peak load station is used when the demand of power is more and cost of the power/unit will be more. The time that a peak plant operates may be many hours a day or as little as a few hours per year, depending on the condition of the region's electrical grid The most of the time electricity will be used during the day hours as the power is required for watermills, textile machines, sawmills etc. The initial capital cost for the hydro power station is more and running cost is less.

Hydro plants are more energy efficient than most thermal power plants, too. That means they waste less energy to produce electricity. In thermal power plants, a lot of energy is lost as heat. Hydro plants are about 95 percent efficient at converting the kinetic energy of the moving water into electricity.

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Beginning of Hydropower in India

India's first major hydroelectric power installation, started generating electricity in 1902. This power installation was from Sivasamudram, which was island located in upper course of cauvery river. This powe house was designed to generate three megawatts. And the power was transmitted to Kolar Gold mines which were under control of British companies.

At that time Gold mining was small business in South India. In the 1880s,. A that time heavy machineries were required to carry mining business like heavy depth operations. Due to shortage of low calorific steam coal which was not available in South India, it was necessary to be brought at considerable expense from distant fields in Hyderabad State and Bengal. Despite the chronic fuel problems, the mining companies were prospering and were investing their profits in new equipment to improve the productivity of the mines. Looking at the above problems the mine engineers at Kolar, thinking that hydroelectricity might meet the gold mines' requirements for a source of inexpensive electricity, kept abreast of recent developments in the USA, at Niagara Falls. The Niagara Power Company had devised a dual strategy for marketing electricity, first through attraction of power consuming electro-chemical and electro-metallurgical to the area, and then through extension of electrical service to Buffalo, New York.

The implement and development of hydropower at Niagara

Falls had determined an electrical frequency suitable for industrial processing, urban lighting and traction and had to develop power lines capable of overcoming recurring problems with lightning, switching and cable insulation. The machinery and technology developed by first Westinghouse and then by General Electric (GE) at Niagara Falls had by 1898 developed into a reproducible power complex that would set the standards for other hydroelectric power installations. GE's work at Niagara Falls was widely known, they had installed hydroelectric power equipment for gold mines in America and South America, and the company was intent upon expanding its sales throughout the world. The power station was named after the island of Sivasamudram, nearby the fall. Mysore retained one of General Electric's engineers, Harry Parker Gibbs, as the Chief Electrical Engineer of the State's new Electrical Department and sent four Indian members of the departmental staff to GE's headquarters in Schenectady, New York for training. Gibbs was later hired by the Tata Hydro-Electric Power Company as General Manager, to supply electricity to cotton textile mills of Bombay City

Later it was found that, the original agreement of 1900 between Mysore State and the Madras Presidency had stipulated that "all water diverted from the river for the power works shall be returned to the river below the fall without being limitations in quantity." Plans in 1910 were made to build a reservoir across the Cauvery River just above Mysore City. This was to be one of the world's first multipurpose reservoirs, for developing more power at Sivasamudram and for irrigation. This brought the Sivasamudram power development into the context of a long standing dispute over the Cauvery River's water. By the end of the 19th Century, the Cauvery River system had been fully utilized for irrigation.. The new exploitation of the Cauvery River led to increased interstate disputes over the projected uses of the river that remain to this day.

Hydro Electric Power Plants

Factors Affecting for selection of Site for Hydro electric

Station:

Amount of water available: Water is the main heart of Hydro power plants. Previous records of rainfall are studied also minimum and maximum quantity of water available during the year are estimated. After allowing for losses due to evaporation and percolation the net volume of water available for power generation can be determined.

Storage of water: Wide variation of rainfall during the year makes it necessary to store water for continuous Generation of power through out year. Intend to provide the sufficient storage for one year or intend to provide the enough storage so as to useful during the worst dry periods.

Head of water: The available water head depends on topography of the area. This is the important factor and it decides the generation of power. low falls on unregulated streams are subject to wide variations which affect the net head, and may, in fact, reduce it to ab abnormality low value, uneconomical for power generation.

Transportation facilities: The site selected for a Hydro plant should be accessible by rail as well as by road.

Distance of Power site from Power grid: If the power site near to power grid, the cost of power will be less. If it is far, the cost will be more.

Types of Hydro Power Plants:

1 **.Run-off Plants without Poundage**: As name indicates this type of plant doesn't store water, the plant uses as water comes.

2**. Run-0ff plants with Poundage**: Poundage permits storage of water during the off –peak period and use of this water during peak periods.

3. **Reservoir Plants**: A reservoir plant is that which has reservoir of such size as to permit carrying over storage from wet season to the next dry season.

4 **.Low head plants:** In this case small dam is built across the river to provide the necessary head. In such plants

Francis type of turbines are used.

5. **Medium head plants**: The fore bay provided at the beginning of Penstock serves as water reservoir for such plants. In these plants water is generally carried out in open canals from reservoir to the Fore bay and then to thepenstock.

6. **High head Plant**: This plants works above 500mtrs and Pelton wheel turbines are commonly used. In this plant water is carried out from the main reservoir by a tunnel up to surge tank and then from the surge tank to the power house in penstock.

7. **Base Load Plants**: These Plants are mainly depending on the nature of load. Is demand is more, this plants are used regularly and load factor of this plants are high.

8**. Peak load Plants**: These plants are mainly used during the peak load. Run-off river plants with pondage can be used as peak-load plants. reservoir plants with enough storage behind the dam can be used either as base load or as peak load plants as required.

9. **Pumped storage plants**: These plants are used when quantity of water available for generation is insufficient. If it is possible to pond at head water and tail water locations afterpassing through the turbine is stored in the tail race pond from where it may be pumped back to the Head water pond.

Achievement of India in Hydro Power

In 1947, there were fewer than 300 large dams in India. India ranks third in the world in dam building, after US and China. From 1947 to till today India has given much importance in constructing dams for Irrigation, hydro electric Power generation etc. In India mainly people are having agricultural lands in which they grow grains, vegetables etc. The natural water will be available in rainy season. In dry season water is supplied through Dams in which water flow is controlled. Required amount of water is supplied. . In fact, large dam construction has been the main form of investment in irrigation undertaken by the Indian government.

Between 1951 and 2000, India’s production of food grains increased fourfold, from 51 million tonnes to about 200 million tonnes. This not only obviated the importation of food grains, with attendant saving in foreign exchange, but left India with a marginal food grain surplus. Proponents point to the fact that about two thirds of this increase was in irrigated areas, and that by the year 2000, areas irrigated by dams constituted 35 percent of irrigated land in India. The most optimistic estimates attribute 25 percent of the increase in food grain production to dam irrigated areas. But it is incorrect to attribute the entire production gains in dam irrigated areas to dams.

The Indian government has had programs to promote power generation from renewable sources for the last 25 years, but the cumulative power generation from these sources is only around 12,000 MW. he Himachal Pradesh plant's availability factor—the amount of time a power plant can produce electricity over a certain period, divided by the amount of time in the period—for the month of July 2009 was 105.26 percent, with the cumulative factor for the station at 102.88 percent. This marks the highest factor achieved by a central sector hydro power station operating in the northern grid.

Large dam construction has been an important and expensive undertaking for the Indian government. While dams have enhanced agricultural productivity in India, there is no evidence that they have been very cost effective, and they have significantly adverse distributional implications. The case of large dams suggests strongly that distributional implications of public polices should be central to any evaluation. Clearly, the case of large dams suggests the need to understand the institutions, and power structures, which led to the implementation of these projects.

By 2012, the country will see three new projects of 1,000 Mw and above. These are the Karcham Wantoo project (1,000 Mw) in Himachal Pradesh, the Tehri pump storage scheme of 1,000 Mw and the 2,000-Mw plant at Subansiri in Arunachal Pradesh. Post independence we have made lots of progress in Dam and Water Reservoirs in India. Dams is basically used for Power generation, Water supply, Stabilize water flow / irrigation, Flood prevention, Land reclamation, Water diversion, Recreation and aquatic beauty. India is very rich is Dam and India is having some of the largest Dams and Reservoirs. There are all the states in India where dams have been established but Karnataka is very rich in having most of dams and Reservoirs. Dams in Karnataka is very popular serving the purpose of people of Karnataka and Bangalore. Karnataka is much enriched in terms Dams in South India.

Hydro Power Stations in India

In India, the conventional alternatives to hydroelectric power are diesel, coal or natural gas. (After the full impact of Chernobyl nuclear disaster became known, there is less talk of nuclear energy as a major alternative. Natural gas has the limitation that its reserves are low). Considering India's coal reserves and the fact that it imports petroleum, coal would rank equally with diesel. Though thermal plants using coal used to be highly polluting, modern technologies have helped to bring down pollution to very low levels. However, coal is ranked below oil in the West as it produces a lot of carbon dioxide, a green house gasA fast growing power sector is crucial to sustain India’s economic growth. India has an assessed hydropower potential to the tune of 84,000 MW at 60% load factor; out of this only about 20%has been developed so far. In the past various factors such as the dearth of adequately investigated projects, environmental concerns, resettlement and rehabilitation issues, land acquisition problems, regulatory issues, long clearance and approval procedures, power evacuation problems, the dearth of good contractors, and in some cases, inter-state issues and law and order problems have contributed to the slow pace of hydropower development. There have been large time and cost overruns in case of some projects due to geological surprises, resettlement and rehabilitation issues, etc. However, considering the large potential and the intrinsic characteristics of hydropower in promoting the country's energy security and flexibility in system operation, the Government is keen to accelerate hydropower development. The Central Electricity Authority (CEA) undertook reassessment of the hydropower resources of the country in 1980s. In this survey, theoretical and the economic hydro potential of the rivers was worked out. The potential was assessed by identifying specific suitable sites and water availability corresponding to a 90% dependable year.

CEA had identified 845 economically feasible schemes in various river basin of the country.

Graph:

Hydro Power station	Thermal Power Station	Nuclear Power	Other
21%	70%	4%	5%

Thermal power plants are generating electricity about 70%, 21% by hydroelectric power plants and 4% by nuclear power plants. Some of the measures announced by; Govt. of India have already been introduced which include simplified procedures for transfer of techno-economic clearances, streamlining of clearance process and introduction of three-stage clearance approach for development of hydro projects in Central Sector/Joint Ventures, etc. he Indian government considers hydropower as a renewable economic, non-polluting and environmentally benign source of energy. Experience of running hydropower stations in India has shown that even after careful project planning and good quality control measures from construction to commissioning, unforeseen problems do occur in service resulting in unplanned outages / low generation and load shedding etc. This causes disruption toconsumers and reduced cash generation for the operator.

Major Steps Taken By India Government:

1) The hydro-electric potential in terms of installed capacity is proposed to be about 148,700 MW out of which a capacity of 30,164 MW (20.3%) has been developed so far and 13,616 MW (9.2 %) of capacity is under construction.
2) In addition, 6,782 MW in terms of installed capacity from small, mini and micro hydro schemes have been assessed.
3) Also, 56 sites for pumped storage schemes with an aggregate installed capacity of 94,000 MW have been identified.
4) The government expects to harness its full potential of hydropower by 2027 with a whopping investment of 5,000 billion Rupees.
5) Additionally, India has committed massive amount of

funds for the construction of various nuclear reactors rather than hydro power plants which would generate at least 30,000 MW.

Hydro Power Generation in the World

The inherent technical, economic and environmental benefits of hydroelectric power make it an important contributor to the future world energy mix, particularly in the developing countries. These countries have a great and ever-intensifying need for power and water supplies and they also have greatest remaining hydro potential. When highlighted Hydro Power in world, it was found that hydropower now supplies about 888.8GW or above 25% of world electricity. Still the construction of large dams are going on, specially the worlds largest is the Three Gorges Dam on the third longest river in the world, the Yangtze River. Annual installed capacity surged during 2004 mainly due to the rise in new installations in China. In addition, rising interest in the sector has led to increased government support policies which will derive installations in many countries. Hydropower, or hydroelectric power generation, is used around the world to generate electricity. Hydropower has been used for thousands of years to convert the energy of water into mechanical work for irrigation, and later to power machinery in the factories of the Industrial Revolution. By the year 2050, the world population is expected to increase by 50 per cent, from 6 to 9 billion. Energy consumption per inhabitant per year is generally in correlation with the standard of living of the population, which is characteristic of welfare from an economic, social and cultural point of view. Today the less developed countries in the world, with 2.2 billion inhabitants, have an annual per capita consumption of primary energy which is 20 times less than those of the industrialized countries (with 1.3 billion inhabitants), and per capita electricity consumption which is 35 times less. Hydroelectric power plants generally range in size from several hundred kilowatts to several hundred megawatts, but a few enormous plants have capacities near 10,000 megawatts in order to supply electricity to millions of people. According to the National Renewable Energy Laboratory, world hydroelectric power plants have a combined capacity of 675,000 megawatts that produces over 2.3 trillion kilowatt-hours of electricity each year; supplying 24 percent of the world's electricity to more than 1 billion customers. Only 2,400 of the 80,000 dams in the United States are used for hydroelectric power. It is costly to construct a new hydroelectric power plant, and construction uses much water and land. In addition, environmental concerns have been voiced against their use. According to the U.S. Geological Survey, the likely trend for the future is toward small-scale hydroelectric power plants that can generate electricity for single communities. A number of countries, such as China India, Iran and Turkey, are undertaking large-scale hydro development programmers, and there are projects under construction in about 80 countries. According to the recent world surveys, conducted for the World Atlas & Industry Guide, published annually by Hydropower & Dams, a number of countries see hydropower as the key to their future economic development: Examples are Sudan, Rwanda, Mali, Benin, Ghana, Liberia, Guinea, Myanmar, Bhutan, Cambodia, Armenia, Kyrgyzstan, Cuba, Costa Rica, and Guyana.

World distribution of hydropower

- Hydropower is the most important and widely-used renewable source of energy.
- Hydropower represents 25% of total electricity production.
- China is the largest producer of hydroelectricity, followed by Canada, Brazil, and the United States (Source: Energy Information Administration).
- There are so many Dams proposed which are considered to be in list of Largest Dams. Presently the

Three Gorges Dam of China having capacity of 22.5GW generation capacity stands in the first position and it will complete by the year 2011

Top Seven Countries in Hydropower generation

Country	Annual hydroelectric production (GWh)	Gene capa
China	585200	196.7
Canada	369500	88.97

Brazil	363800	69.08
United States	250600	79.51
Russia	167000	45.00
Norway	140500	27.52
India	115600	33.60

Top Future Three Largest Dams Generating Power above 10GW

Name	Capacity (GW)	Country	Construction Completion
Grand		Congo DR	

Inga Dam	39		2014	2025
Three Gorges Dam	22.5	China	1994	2011
Baihetan Dam	13.050	China	2009	2015

Dam

A dam is defined as any impounding structure that is either 25 feet in height, measured from the downstream toe to the crest, or has a maximum impounding capacity of 50 acre-feet of water. The function of Dam is to provide a head of water to be utilized in the water turbine. Though many Dams may be built solely to provide the necessary to the plant a Dam also increases reservoir capacity. Dams are built of concrete or stone masonary, earth or rock fill. The type and arrangement depends upon the topography of the site. A masonary dam may be built in a narrow canyon. An earth dam may be suited for a wide valley. The type of dams also depends on the foundation conditions, local materials and transportation available, occurrences of earthquakes and other hazards. Structures that fail to meet these criteria but have the potential to cause significant property damage or pose a threat to life in the downstream area are regulated in the same manner as dams. All such structures except federal dams and those permitted by the Division of Mine Reclamation and Enforcement must be reviewed, and a stream construction permit must be issued by this office. Design criteria, hazard classification information and submittal requirements can be found in the publication "Design Criteria for Dams and Associated Structures."

Construction inspections are performed periodically and during critical stages of work. Upon completion of construction, the owner submits a notice of completion and as-constructed drawings. When as-constructed drawings are received, a final inspection is conducted. If all work is satisfactory, the owner is granted permission to impound water and the completed dam is placed on the inventory of dams maintained by the section.

Intended purposes include providing water for irrigation to a town or city water supply, improving navigation, creating a reservoir of water to supply industrial uses, generating hydroelectric power, creating recreation areas or habitat for fish and wildlife, retaining wet season flow to minimize downstream flood risk and containing effluent from industrial sites such as mines or factories. Some dams can also serve as pedestrian or vehicular bridges across the river as well. When used in conjunction with intermittent power sources such as wind or solar, the reservoir can serve as pumped water storage to facilitate base load dampening in the power grid. Few dams serve all of these purposes but some multi-purpose dams serve more than one.

Failure of dams:

Water leakage: If there action is not taken at the right time when water leakage is observed, leads to Dam failure. Proper maintenance is required to maintain the dam for long life. It is necessary to anticipate any problems and action to be taken before structure fails

Poor Maintenance: If maintenance is not carried at regular intervals, leading to Dam failure.

Spillway design error: When river flow exceeds the storage capacity, the dysfunctional spillway leads to dam failure.

Poor Survey: Dams built on slopes must be properly engineered to avoid issues with instability or landslide. If it is still continued, leads to Dam Failure.

Material: Building material used for the dam should be of high quality. Low quality building material leads to dam failure.

Maintenance: Poor maintenance like when water is overflowing, if the Gates are not worked properly, leads to dam failure.

Foundation: Defects can occur in the foundation supporting the dam. If this weight is not properly taken into account in the engineering of the dam, the ground underneath can settle unequally and compromise the foundation .Similarly, any event causing the movement of a foundation, such as an earthquake, can also compromise a dam's foundation. The main cause of concrete dam failure is a problem with the foundation. High uplift pressures and uncontrolled foundation seepage can also compromise the dam's foundation. When the foundation of an earth fill dam is composed of fine silt, clay, or similar soft soil, the whole dam may slide due to water thrust. If seams of fissured rocks, such as soft clay, or shale exist below the foundation, the side thrust of the water pressure may shear the whole dam and cause its failure. In such failure the top of the dam gets cracked and subsides, the lower slopes moves outward and forms large mud waves near the dam heel.

Seepage failure: Seepage always occurs in the dams. If the magnitude is within design limits, it may not harm the stability of the dam. However, if seepage is concentrated or uncontrolled beyond limits, it will lead to failure of the dam.

Following are some of the various types of seepage failure.

i) Piping through dam body: When seepage starts through poor soils in the body of the dam, small channels are formed which transport material downstream. As more materials are transported downstream, the channels glow bigger and bigger which could lead to wash out of dam.

ii) Piping through foundation: When highly permeable cavities or fissures or strata of gravel or boorish sand are present in the dam foundation, it may lead to heavy seepage. The concentrated seepage at high rate will erode soil which will cause increase flow of water and soil. As a result, the dam will settle or sink leading to failure. Strength.

Disadvantages:

Human land Loss: So many poor people are lost their lands as result of Dams. People who already lost agricultural lands caused major unemployment in some countries like India etc.

Failure of dam: Dam is major storage of water. The dam failure leads, too many people die and it is like flooding in small towns.

Overflow of water: Over topping of dam during rainy season leads to vacate the houses of many people in small towns.

Advantages:

Cheap: If the dam is maintained properly, a hydroelectric power source is comparatively cheap.

Reliable: Once Dam is constructed with well design and quality Engineers then dam will be having long life and reliable. It has no fuel and low escape risk, and as an alternative energy source it is cheaper than both nuclear and wind power.

Biggest dam failure:

Banqiao Shimantan- China.:

The Bangiao Dam was originally designed to pass about 1742 cubic meters per second through sluice gates and a spillway. The capacity storage capacity was set at 492 million cubic meters with 375 million cubic meters of this capacity reserved for flood storage. The height of the dam was at little over 116 meters. Once the Banqiao and Shimantan Dams were completed many, many smaller dams were built. Initially the smaller dams were built in the mountains, but in 1958 Vice Premier Tan Zhenlin decreed that the dam building should be extended into the plains of China. The Vice Premier also asserted that primacy should be given to water accumulation for irrigation. A hydrologist named Chen Xing objected to this policy on the basis that it would lead to water logging and alkinization of farm land due to a high water table produced by the dams. Not only were the warnings of Chen Xing ignored but political officials changed his design for the largest reservoir on the plains. Chen Xing, on the basis of his expertise as a hydrologist, recommended twelve sluice gates but this was reduced to five by critics who said Chen was being too conservative. There were other projects where the number of sluice gates was arbitrarily reduced significantly. Chen Xing was sent to Xinyan.

1) On 5 August 1975, Banqiao Reservoir filled to close to maximum capacity. On that day the reservoir rose to more than two meters above its designed safe capacity.

2) On the evening of 7 August Sluice gates were opened, but were found to be partly blocked with sediment. Banqiao Dam was collapsed, and 500 million cubic meters of reservoir water surged over the downstream valleys and plains at nearly 50 kilometers per hour. ‘Entire villages and small towns disappeared in an instant.

3) By August 8 the Banqiao and Shimantan Dam reservoirs had filled to capacity because the runoff so far exceeded the rate at which water could be expelled through their sluice gates. Shortly after midnight (12:30 AM) the water in the Shimantan Dam reservoir on the Hong River rose 40 centimeters above the crest of the dam and the dam collapsed. The reservoir emptied its 120 million cubic meters of water within five hours.

The floodwaters from the reservoirs and rivers of the Huai

Basin combined to form a lake covering thousands of square kilometers, partially or completely submerging countless villages and small towns. Faith in the ability of dams to hold back flooding had meant that for decades, dike maintenance, river dredging and flood diversionary systems within the basin had been neglected, and there were few outlets through which the newly-created lake could drain. A week after the lake formed, several of the surviving dams in Henan — including some built especially for flood control — were dynamited because it was decided that this was the only way to let the water escape.

The vast lake ruptured transport and communications throughout the region, making many areas inaccessible to disaster relief teams and medical workers. The pseudonymous Chinese journalist describes the aftermath of the dam bursts:

4) August 13: Two million people across the district are trapped by the water . In Runan, 100,000 who were initially

submerged but somehow survived are still floating in the water. In Shangcai, another 600,000 are surrounded by the flood; 4,000members of Liudayu Brigade in Huabo Commune have stripped the trees bare and eaten all the leaves. People in the flooded areas who survived had to face an equally harrowing ordeal. They were trapped and without food for many days. Many were sick from the contaminated water

5) August 17: There are still 1.1 million people trapped in the water . . . the disease morbidity rate has soared. According to incomplete statistics, 1.13 million people have contracted illnesses . . .

6) August 18: Altogether 880,000 people are surrounded by water in Shangcai and Xincai. Out of 500,000 people in

Runan, 320,000 have now been stricken with disease, including 33,000 cases of dysentery . . .

Some two weeks after the disaster, when the flood waters finally began to retreat in certain areas of Zhumadian Prefecture, mounds of corpses lay everywhere in sight, rotting and decaying under the hot sun.

Human Rights Watch believes that the most likely interpretation of the few and contradictory statistics available on the death toll from the disaster is that 85,000 were killed by the immediate flood waves from the failed dams, and a further 145,000 died in the epidemics and famine which struck the area in the ensuing weeks.


Infrastructure Loss Due to
Dam Failure in China


Dam Failure of
Banqiao Shimantan- China

Role of Draft Tube in Hydro Power Station

The draft tube is of welded steel construction and consists of a cone and elbow liner. A water and air tight man-hole access having clear opening with hinged door, bronze hinge pins, stainless steel bolts and jacking screws has been provided in cone. A test cock and a pressure gauge are provided. Slots are provided below the manhole for supporting an inspection platform. When water flows on the turbine there is sudden pressure difference in existing between water in the turbine and atmosphere. Therefore turbines are completely enclosed. Hence it is necessary to connect the turbine outlet by means of a pipe or passage like conic shape up to tail race level. The simplest and most efficient, turbine draft tube is the conical shaped draft tube. It is usually vertical and is designed with a truncated cone similar to an inverted ice cream cone. Originally, turbines were designed without draft tubes. In order to work on the runner, stop logs were inserted into the tailrace training walls and the discharge pit was pumped out. It converts a large proportion of the velocity energy rejected from the runner into useful pressure head i.e. it acts recuperates of pressure of energy.

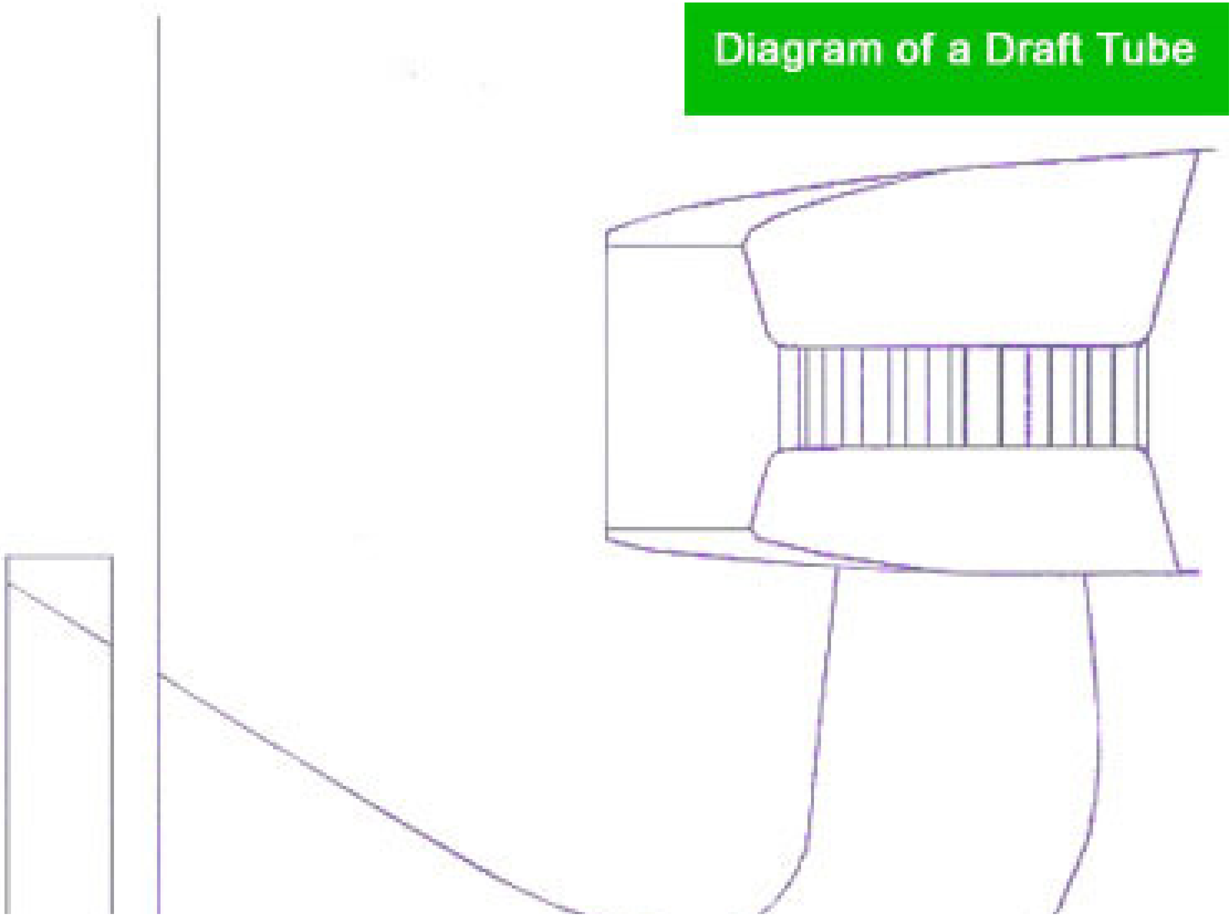


Diagram of a Draft Tube

Penstock

Penstocks are open or closed conduits which carry water to the turbines in hydro power stations. Penstock is generally made of reinforced concrete or steel. Concrete penstocks are suitable for low heads less then 30mtrs.The steel penstocks are designed for any head. The thickness of penstocks increases with head or water pressure. When the distance from the forebay to the power house is short separate penstocks are used for each turbine. In high head dams, the penstocks are provided with penstock gates or butterfly valves and air valves. The penstocks gates are fixed to initial of penstocks, and flow of water is controlled by operating penstock gates. In high head power plants the butterfly valve and air valve are provided in the power houses. Air valve maintains the air pressure inside the penstock equal to atmospheric pressure. When water runs out of penstock faster then it enters, a vacuum created which may cause the penstock to collapse. Under such circumstances, air valve opens and admits the air in the penstock to maintain inside equal to the outside pressure. If the butterfly suddenly opens and water enters with high pressure there will be chances of penstock collapse. Hence there is a water pressure valve fixed before the butterfly valve, which maintains the water pressure at the both sides of penstocks by bypassing butterfly valve. Before operating the butterfly valve, this water pressure valve operates and fills up the water at the other side of penstock. The setting of system is such that the butterfly valve operates, when the water pressure at the both sides of penstocks are equal.

There are two types of penstocks in which are mainly used for power generation

Low Pressure Penstocks: The low pressure type consists of a canal commonly flume or a pipe.

High Pressure Penstocks: The high pressure consists of steel pipes which can take water under pressure.

Water Turbines:

Water turbines are used to convert the energy water of falling water into mechanical energy. A water turbine is a rotary engine that takes energy from moving water. Water turbines were developed in the nineteenth century and were widely used for industrial power prior to electrical grids. Now they are mostly used for electric power generation. They harness a clean and renewable energy source. Flowing water is directed on to the blades of a turbine runner, creating a force on the blades. Since the runner is spinning, the force acts through a distance (force acting through a distance is the definition of work). In this way, energy is transferred from the water flow to the turbine.

The principal types of turbines are:

1) Impulse turbine
2) Reaction Turbine

Impulse turbines: These types of turbines are mainly used in high head plants. In this turbine the entire pressure of water is converted into kinetic energy in a nozzle and the velocity of the jet drives the blades of turbine. The nozzle consist of a needle, and quantity of water jet falling on the turbine is controlled this needle placed in the tip of the nozzle. If the load on the turbine decreases, the governor pushes the needle into the nozzle, thereby reducing the quantity of water striking the turbine.

Newton's second law describes the transfer of energy for impulse turbines.

Impulse turbines are most often used in very high (>300m/984 ft) head applications.

Power

The power available in a stream of water is;

$$P = \eta \cdot \rho \cdot g \cdot h \cdot \dot{q}$$

where:

- P = power (J/s or watts)
- η = turbine efficiency
- ρ = density of water (kg/m³)
- g = acceleration of gravity (9.81 m/s²)
- h = head (m). For still water, this is the difference in height between the inlet and outlet surfaces. Moving water has an additional component added to account for the kinetic energy of the flow. The total head equals the pressure head plus velocity head.

- $\dot{q}$ = flow rate (m³/s)

Examples of Impulse turbines are:

- Pelton Wheel.
- Turgo
- Michell-Banki (also known as the Crossflow or Ossberger turbine.

Reaction Turbine:
Examples of reaction turbines are:

1) Francis turbine
2) Kaplan turbine

Reaction turbines are mainly for low and medium head plants. In reaction turbine the water enters the runner partly with pressure energy and partly with velocity head. Most water turbines in use are reaction turbines and are used in low (<30m/98 ft) and medium (30-300m/98–984 ft)head applications. In reaction turbine pressure drop occurs in both fixed and moving blades. In this turbine the runner blades changed with respect to guide vane opening. As the sudden decrease of load takes place, the guide vane limit decreases according to that runner blade closes.

Spillways

Spillways may be considered a sort of safety valve for a Dam. Passage for surplus water over or around a dam when the reservoir itself is full. Spillways are particularly important safety features for earth dams, protecting the dam and its foundation from erosion. They may lead over the dam or a portion of it or along a channel around the dam or a conduit through it. There are times when the river flow exceeds the storage capacity of the reservoir. Such a situation arises during the heavy rain fall in the catchments area. In order to discharge the surplus water from the storage reservoir into the river on the downstream side of dam, spillways are used.

Spillways are constructed f concrete piers on the top of the dam. Gate are provided between piers and surplus water is discharged over the crest of the dam by the opening these gates.

There are two types of Spillways:

Controlled spillway

In this type Gates are provided to regularize the flow of water. When water is overflowing the dam, gate are mainly used to control the pressure of water.

Uncontrolled spillway

In this type, gates are not provided. When the water rises above the ''crest'' of the spillway it begins to be released from the reservoir. The rate of discharge is controlled only by the depth of water within the reservoir. All of the storage volume in the reservoir above the spillway crest can be used only for the temporary storage of floodwater, and cannot be used as water supply storage because it is normally empty.

Role of Hydro Electric Stations in Power Industry

In Power industry, three types of power plants exist: the first one being Thermal (Fossil fuel powered), the other is Nuclear Power plant (Energy released in fission reaction). The third one is Hydro-Electric plant where power is generated from the generator coupled with the turbine- turbine being rotated by water energy. All types of power stations are linked together by HV/EHV transmission lines.

Power generated must be used as soon as it is generated. Thus, it is obvious that at any time the power demand must by equal to generation. However, power demand not often remains constant. It varies with time of day and in seasons. Thus generation is needed to be adjusted all through.

Thermal power plants are put into service throughout the day though the generation capacity may to some extent vary. Nuclear plants supply the base loads and hydro electric plants can be utilized to take care of the flexibilities in the generation and demand. Its power output can be altered very quickly. Hydro electric plants can also be utilized as reserve capacity plants.

In some hydel power stations the dam is constructed only for irrigation purpose. Power should be generated whenever water demand increased by farmers in irrigation dams. Irrigation can be remarkably improved by routing the canals in the downstream of the hydel plants. Draught and flood both can be effectively controlled utilizing the dam water and discharge water of hydel plants.

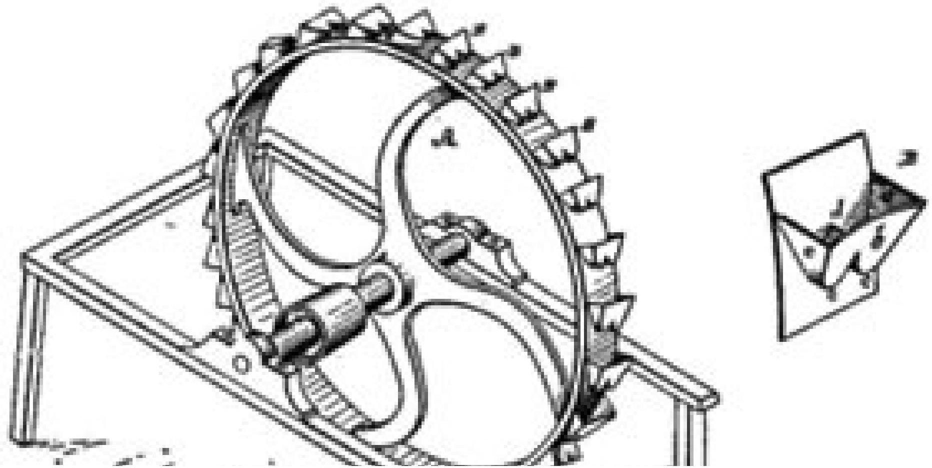
Though hydro-electric power can effectively serve major share in power generation still the role played by it cannot be fully evaluated by the share of hydro power in the overall production alone. Apart from purely power generating aspect, hydel stations have most commendable effect on environmental control and much lower man-power requirement. Hydel-elecric power doesn’t pollute the atmosphere and the unit cost of production of energy is obviously low as the main’ fuel’ is only water. However, the hydel generation is to some extent dependent on weather variations.

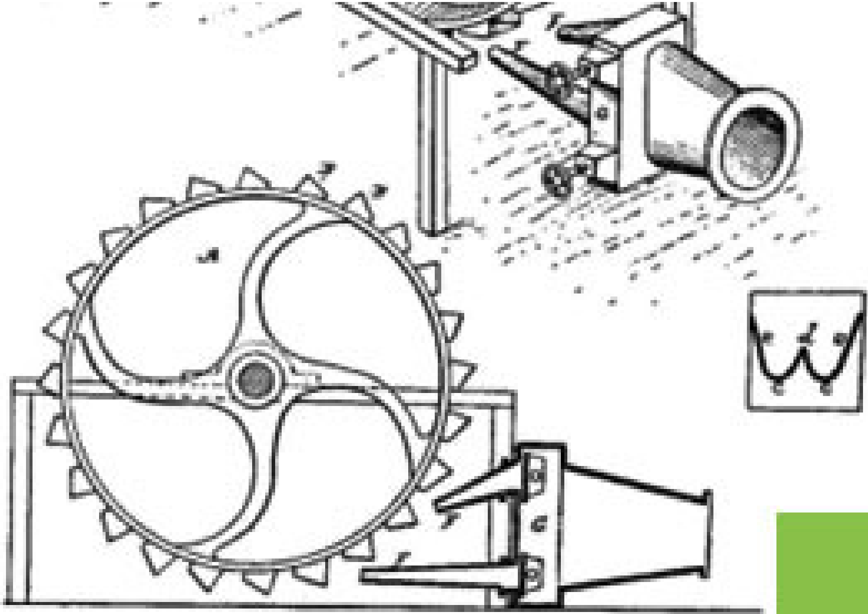
Pelton wheel

A Pelton wheel, also called a Pelton turbine, is one of the most efficient types of water turbines. It was invented by Lester Allan Pelton (1829-1908) in the 1870s, and is an impulse machine, meaning that it uses Newton's second law to extract energy from a jet of fluid.

The Pelton wheel turbine is a tangential flow impulse turbine, water flows along the tangent to the path of the runner.

Studying the high head plants the Pelton turbines are designed. The Pelton turbines are available in various sizes. Depending on that number of nozzles decided. Nozzles are arranged around the wheel such that the water jet emerging from a nozzle is tangential to the circumference of the wheel of Pelton Turbine. Accordingly Nozzles direct forceful streams of water against a series of spoon-shaped buckets mounted around theedge of a wheel. Each bucket reverses the flow of water, leaving it with diminished energy. The resulting impulse spins the turbine. The buckets are mounted in pairs, to keep the forces on the wheel balanced, as well as to ensure smooth, efficient momentum transfer of the fluid jet to the wheel. The Pelton wheel is most efficient in high head applications. For a constant water flow rate from the nozzles the speed of turbine changes with changing loads on it. For quality hydroelectricity generation the turbine should rotate at a constant speed. To keep the speed constant despite the changing loads on the turbine water flow rate through the nozzles is changed. To stop the striking water jet to the turbine blades when load decreased on the turbine, the servo controlled spear valves are used in jets. In sudden reduction of load jets are made to stop by deflector plates so that over speed of turbine should not take.



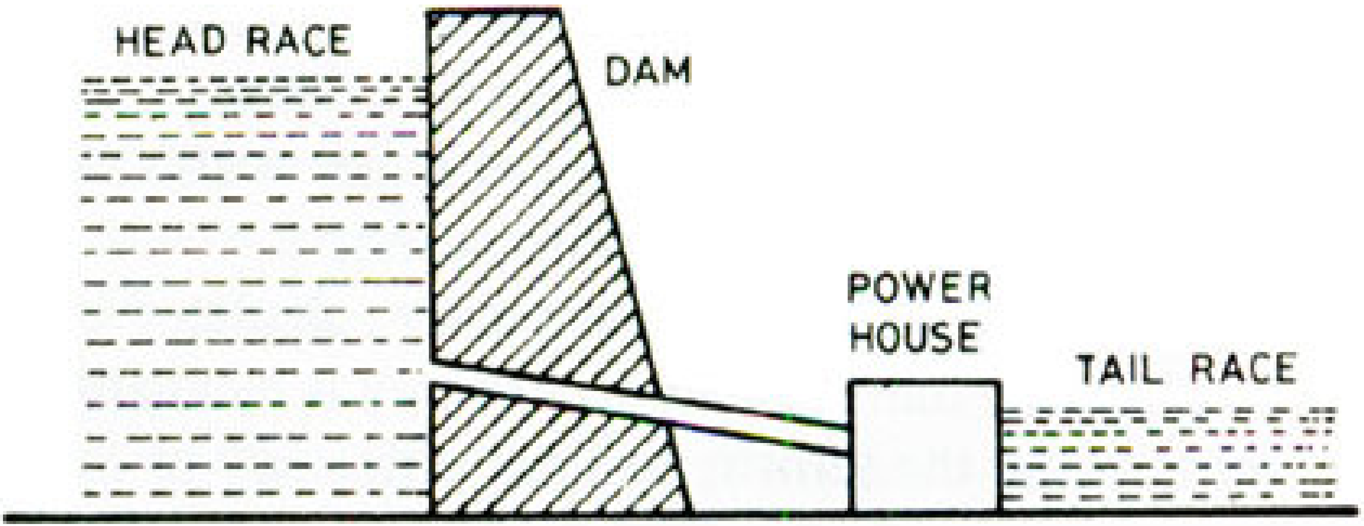


Pelton Wheel

Low head Power Plants

In this case a small dam is built across the river to provide the necessary head. The excess water is allowed to flow over the dam itself. In such plants Francis, Propeller or Kaplan types of turbines are used. Also no surge tank is required. These plants are constructed where the water head available less then 30mtrs. The production of electricity will be less due to low head.

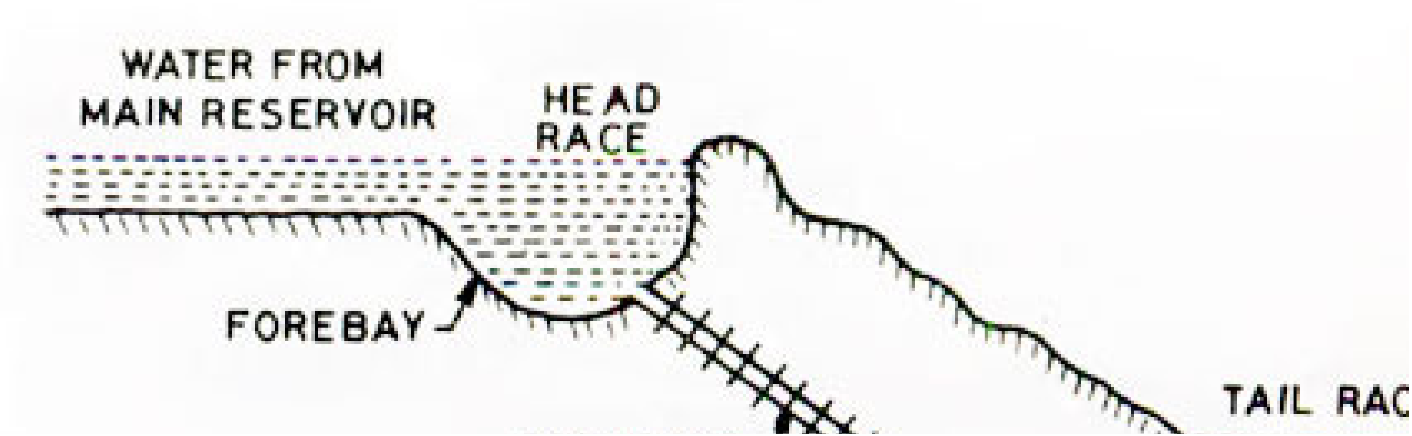
Low Head Plant


HEAD RACE
DAM
POWER
HOUSE
TAIL RACE

Medium Head Hydro Power Plants

Mainly forebay provided before the Penstock, acts as water reservoir for medium head plants. In this plants mainly water is carried through main reservoir to forebay and then to the penstock. The forebay acts as surge tank for these plants. The turbines used will be Francis type of the steel encased variety.

Medium Head Plant

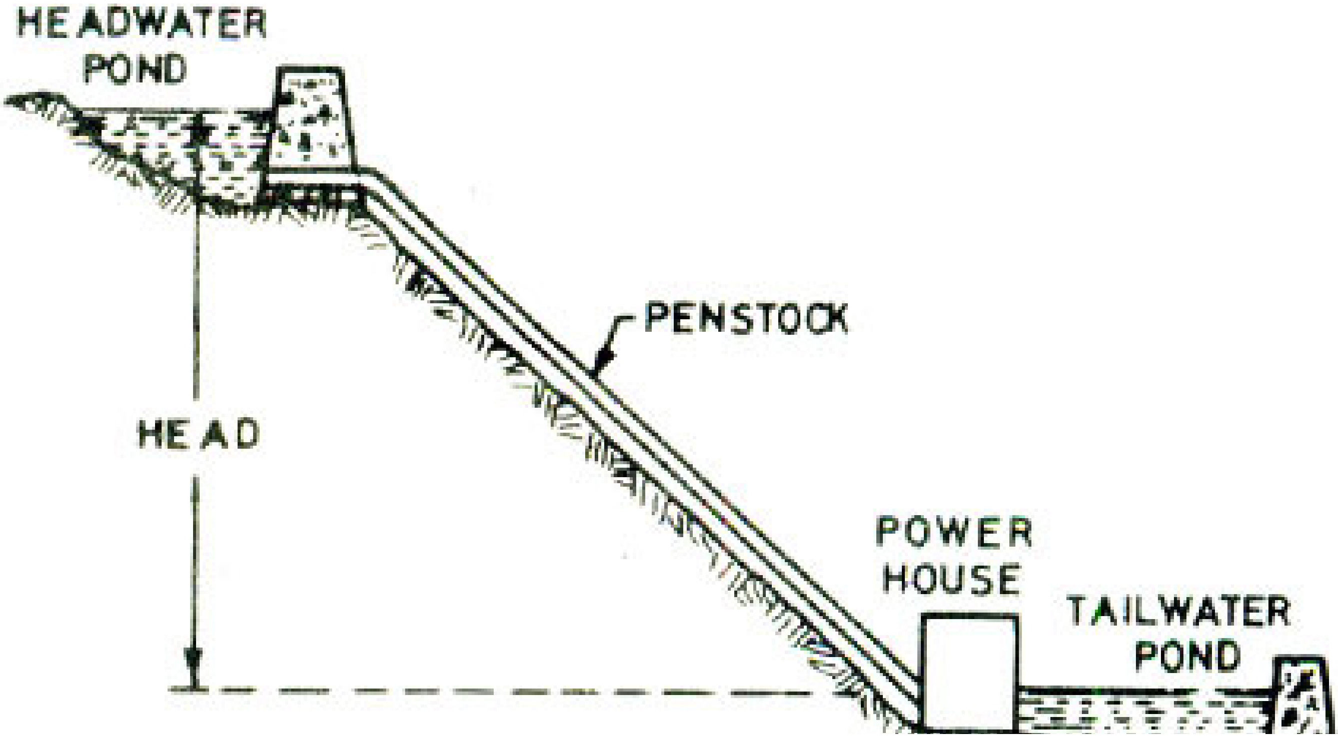



PENSTOKE
POWER HOUSE

Pumped Storage Hydro Power Plants

In these plants mainly water is pumped back for more generation of power. Pumped-storage hydroelectricity is a type of hydroelectric power generation used by some power plants for load balancing. The method stores energy in the form of water pumped from a lower elevation reservoir to a higher elevation. Low-cost off-peak electric power is used to run the pumps.. These plants are used when amount of water available for generation of power is otherwise inadequate. If it is possible to pond at head water and tail water locations water after passing through the turbine is stored in the tail race pond where it may be pumped back to head water pond. The pumping back from tail race pond to the head water pond is done during off-peak period. During peak load period water is drawn from the head water pond through the penstock to operate the turbines.

Although the losses of the pumping process makes the plant a net consumer of energy overall, the system increases revenue by selling more electricity during periods of peak demand, when electricity prices are highest. Pumped storage is the largest-capacity form of grid energy storage now available. Such plants can recover almost 70% of the power used in pumping the water. A recent development in this field is the use of reversible turbine-pump unit. Such unit can be used as a turbine while generating power and as pumping water to storage. The generator in this case works as motor during reverse operation. The efficiency in such a case is high and is almost the same in both the operations. With the use of reversible – turbine- pump sets additional capital investment on pump and its motor can be saved and the scheme can be worked more economically. Such plants can be operated only in interconnected systems where other generating plants (steam, hydro etc.) are also available.



Pumped Storage Plant

A pumped-storage plant has two reservoirs

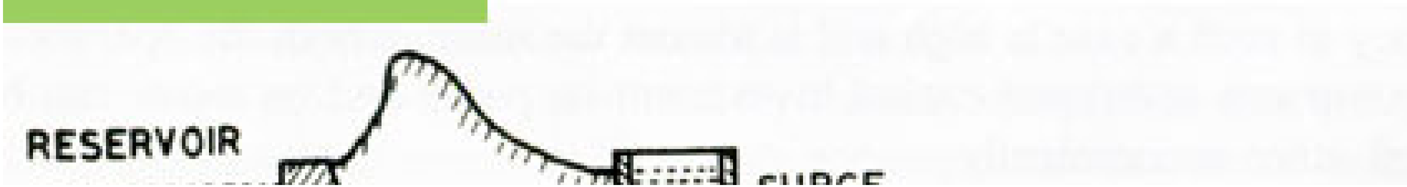
Upper reservoir - Like a conventional hydropower plant, a dam creates a reservoir. The water in this reservoir flows through the hydropower plant to create electricity. Using a reversible turbine, the plant can pump water back to the upperreservoir. This is done in off-peak hours. Essentially, the second reservoir refills the upper reservoir. By pumping water back to the upper reservoir, the plant has more water to generate electricity during periods of peak consumption.

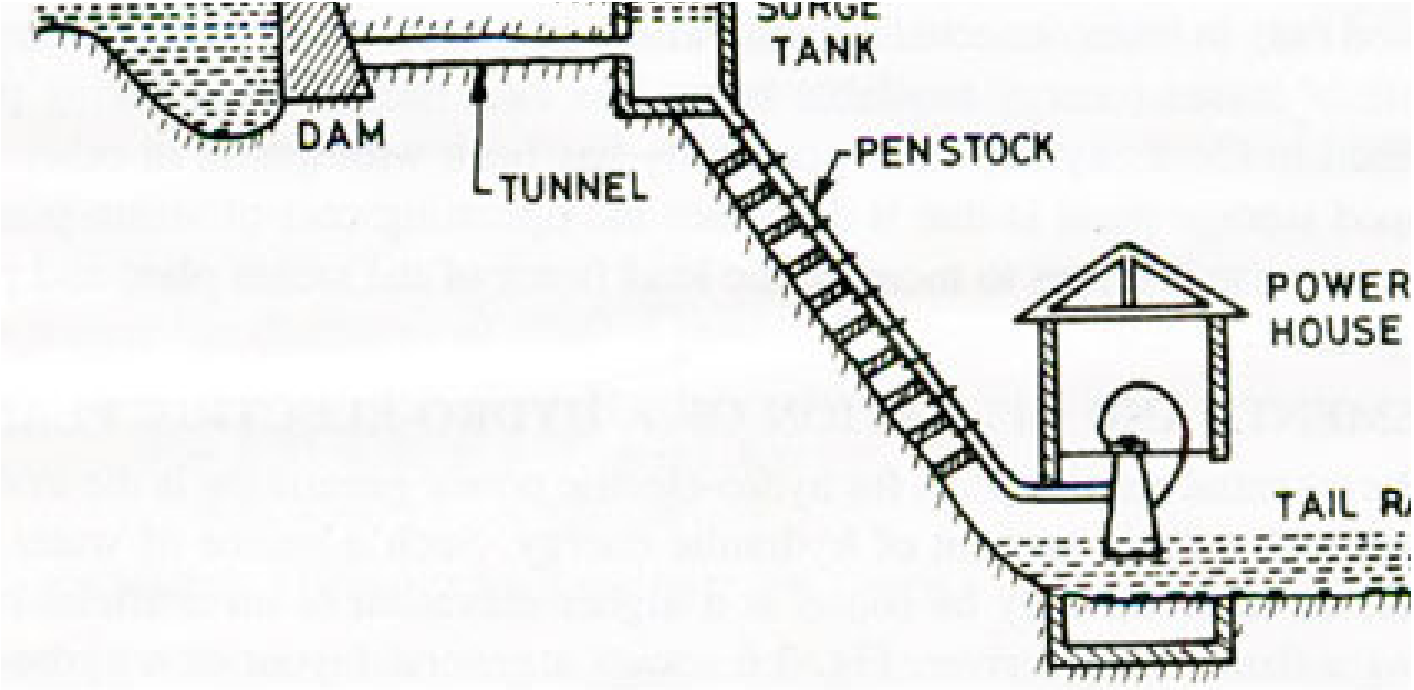
Lower reservoir - Water exiting the hydropower plant flows into a lower reservoir rather than re-entering the river and flowing downstream.

High Head power plant

Mainly in these plants pressure tunnel is provided before the surge tank, which inturn connected to penstock. A pressure tunnel is taken off from the reservoir and water brought to the valve house (not shown in picture) at the start of the penstocks. The penstocks are huge steel pipes which take large quantity of water from the valve house to the power house. The valve house contains main sluice gates and in addition automatic isolating valves which come into operation when the penstock bursts, cutting further supply of water. Surge tank is an open tank and is built just in between the beginning of the penstocks and the valve house. In absence of surge tank, the water hammer can damage the fixed gates. InMajority of dams Sluice gates are provided. The sluice gates are opened when dam level is below level and there is shortage water for irrigation. Normally the high head plants are 500 meters above and for heads above 500 meters Pelton wheels are used.

High Head Plant




SURGE
TANK
DAM
TUNNEL
PEN STOCK
POWER
HOUSE
TAIL RA

Spiral Casing

The spiral casing and stay ring are fabricated from steel plates. The spiral casing is of logarithmic form and circular cross section for maintaining a constant velocity through its passage. The plates are gradually reduced in thickness to suit hydraulic load. The spiral casing has been made in different number segments which are welded to each other and with stay ring at site. Stay ring is made in two parts, joined by machined flanges and fasteners and steel welded. The top cover and runner envelop are attached to stay ring flanges. Before 1849, in old turbines spiral casing was not there and water was directly following in the centre of the runner and was radially flowing outwards. At that time the American Engineer, James B. Francis, set out to improve upon the design of the few hydraulic turbines operating at the time in France and the United States.

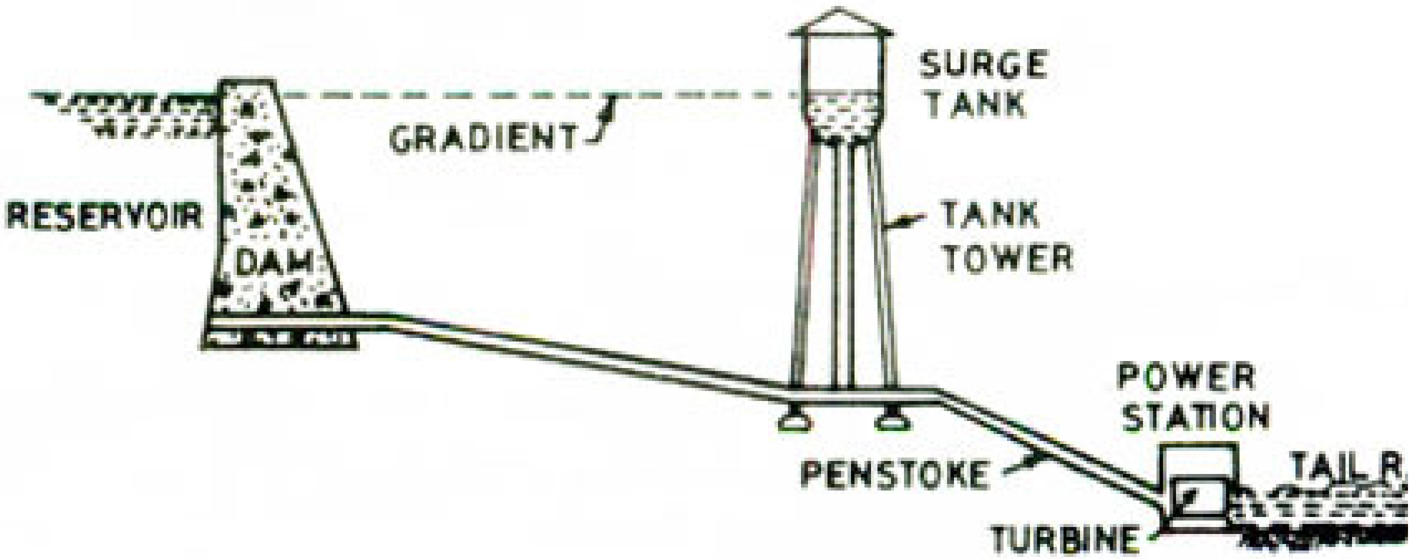
All investigations of this Engineer proved that water to enter the runner from the outside and to flow inward through the radial blades. Afterwards the design was improved so that the water was turned from a radial to an axial path within the runner, rather than outside it. Looking at the result it was found that the water pressure can be controlled and turbine was named as Francis. Mainly Francis turbines are comes under Reaction turbines. The reaction turbines designed as per velocity and the pressure of the water. Water pressure in the penstock is more and directly hitting on the runner may damage the runner blades. The reaction turbines controls the flow of water equally maintains the turbine speed.


Spiral Casing

Surge tank

Surge tank is additional storage for near to turbine, usually provided in high head plants. A surge tank is located near the beginning of the conduit (penstock). When turbine is running at a steady load, there are no surges in the flow of water through the conduit i.e. the quantity of water flowing in the conduit is just sufficient to meet the turbine requirements. As the load on the turbine decreases or during load rejection by the turbine the surge tank provides space for holding water. Similarly when load on turbine increases it furnishes additional water. Thus the conduit (penstock) prevented from bursts. Hence, a surge tank over comes the abnormal pressure in the conduit when load on the turbine falls and acts as a reservoir during increase of load on the turbine. Several designs of surge tanks have been adopted in power stations, the important considerations being the amount of water to be stored, the amount of pressure to be release off and the separate space available at the site of construction.

Surge Tank


SURGE
TANK
GRADIENT
RESERVOIR
DAM
TANK
TOWER
POWER
STATION
PENSTOKE
TAIL R
TURBINE

Guide Bearing

The Guide bearing is of pivoted pad type with self contained oil bath lubrication. It consists of Babbitt lined pads arranged along the outer circumference of skirt of the shaft. Each pad is adjustable by means of studs. The pads remain pivoted against the spherical end of studs. The bearing housing is of split construction and is secured on the upper side of to cover by studs. Four dowels are used for locating bearing housing on top cover. In stationary condition, the pads are kept immersed in oil bath up to a level slightly above the centre line of bearing. Rotation of shaft induces centrifugal force, due to which oil flows through the holes in shaft collar and rises along the journal surface, thus lubricating the pads. The oil returns through the pipe line bearing body and is led to the oil sump by gravity.

The oil cooled in the oil sump which is directly placed on turbine top cover and cooling is carried out by main turbine discharge. The oil after passing through the tank flows back into the bearing through a pipe line provided on bottom ring.

This above article explained as per practically observed in Kaplan Turbine. Normally in all type of turbines same type of guide bearing followed.

India to construct tunnel for quake studies

An eight-km deep underground tunnel next to one of India's largest dams overlooking a picturesque lake in southern Maharashtra may soon provide scientists with vital clues on how earthquakes can be predicted.

Through the tunnel, scientists will lower a string of instruments for setting up an underground seismic observatory, which will collect data to help understand the complex geophysical processes leading to an earthquake.

"Koyna is the only place in the world for this experiment as quakes are happening within a small area of 20x30 km and even within that 600 sq km, they are concentrated within a core area of 5 sq km," Harsh Gupta, who successfully predicted Koyna dam's potential to trigger earthquake more than three decades ago told Deccan Herald on the sidelines of the 98th Indian Science Congress here.

The first step on this Rs 350-crore experiment would be taken on Friday with India signing a memorandum of understanding with the International Continental Drilling Programme ensuring participation of foreign scientists in this project. "By June, we would be able to finalise the scientific plans and go for the Cabinet approval. The actual construction work may start only in 2012," said Shailesh Naik, secretary in the Ministry of Earth Sciences.

An international workshop will be organised in March. Later, scientists will go to the site to decide the tunnel's exact location.Once the observatory is in place, the researchers will record hundreds of tiny quakes with magnitude one and more every year besides four to five quakes of magnitude 2 and at least five to six quakes of magnitude 3 and above. They also hope to get at least one magnitude 4 or 5 quake once in every two years.

The experiment has been initially planned for five years involving a large number of institutions and universities.There will be enough number of earthquakes to generate data on the stress build up and how the rock behaves under stress condition. This will help understand the physics of earthquake, using which a prediction model can be developed.

"With fresh information, our approach to earthquake prediction will be closer to reality," said Gupta who had once forecast on quakes in the north-east and raised red flags on Koyna.Even though deep boreholes were dug to install underground observatories in Kobe (Japan) and Chi Chi (Taiwan), those tunnels were dug at the boundaries of tectonic plates and did not yield much information.

The experiments can neither be conducted at the 1,300-km-long San Andreas fault in California nor in the Himalayan range as there is no way to find out the exact region where the stress is being built up.

Water to be released from Gorur Dam

New food and civil supplies minister V Somanna decided to release water for planting the seeds and standing crops in Hassan, Mandya and Tumkur districts from February week by utilizing the 13.12 tmcft of water from Gorur Dam. It was decided on 19th Jan-2011 in an advisory committee on the Hemavathi irrigation project headed by V Somanna and also attended by legislators and officials of irrigation departmentof the Hemavathi Project.

V Somaana also said 1.905tmcft of water would be used for drinking water and also directed Kaveri Neeravari Nigama Managing Director M A Sadiq for submitting report on the rehabilitation measures required for families in 10villages in the Hemavathi basin adversely affected by seepage of water from irrigation canals.

The Hemavathi River impounded behind the Gorur Dam, which is situated about 12km from Hassan to Arakalagud. Hemavathi Reservoir is also a pilgrim spot, owing to the notable temples located near the site. The water-level is being maintained at 2922 ft. The present storage in the reservoir is 37.103 tmcft.