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Review on Hydroelectric Power Plants

[1]Dr. B. V. Suresh, [2] Radi Jashwanth

[1]Sr. Assistant Professor, GMR Institute of Technology
[2]GMR Institute of Technology

ABSTRACT:

A comprehensive literature review on the operation on hydro power plants electricity generation, turbine used, impacts on agriculture, power generation and water distribution, sources of vibration. Experiment conducted in order the dam can withstand of seismic waves. Use of hydro energy through a long time (sustainable development) which is easier to generate the electricity, dam safety, sources of vibration and risk analysis.

Introduction:

The development of the hydropower plant plays an important role in the development of the country. The power generated by the water is cheapest as it is natural source of energy. It helps for irrigation and flood control in addition to power generation. Nearly 30% of total power of the world is generated using hydro plants. Based on the pressure heads hydropower plant classified as high, medium , small and micro head. Hydro power is one of the oldest and largest sources of renewable energy, which uses the natural flow of moving water to generate electricity. Because of hydropower plants can generate power to grid immediately, they provide essential backup power during major electricity outages. Hydropower works by harnessing the energy that comes from the flow of water through a turbine it into electricity. Most hydropower plants store water in a dam, which is controlled by a gate or valve to measure the amount of water that flows out.

Large Head Hydro Power Plants(above 300m)

Konya Hydro Power Plant

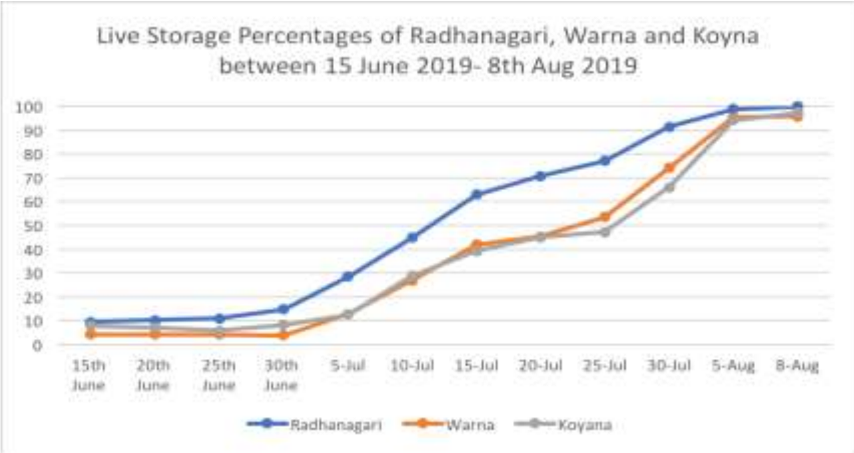
The Konya Dam is one of the largest dams in India. It is a rubble-concrete dam constructed on Koyna River which rises in Mahabaleshwar, a hill station in Sahyadri ranges. The concrete gravity dam is 103 m high and 70 m wide at its base. It is made up of rubble concrete dam is 2648 ft long and the top of the dam is764 m above from the sea level. Upstream water head was 91.7 m when a 6.5 magnitude earthquake shook the region in 1967.koyna dam has been the India's largest station in terms of installed capacity (1960 MW) since 1964.this completed 8 years of construction. The spillway of the dam is located at the centre. It has 6 radial gates. The dam plays a vital role in flood control in monsoon season. It is one of the largest civil engineering projects commissioned after Indian independence. The Koyna hydro-electric project is run by the Maharashtra government. This culminated in a burst of seismic activity from September 1967 to January 1968 this experiment concluded that koyna project can bear 5 - 5.5 magnitude of seismic waves. During the next five years water levels were kept low and no significant earthquakes occurred subsequent to the October 29, 1968 earthquake of magnitude 5.**[1,2]**

POWER GENERATION AND CAPACITY:

In power generation this project consists of four stages the 1st and 2nd stages share same power house with total eight Pelton turbines as a unit. Each two stages have four turbines of capacity 65MW each for 1st stage and 75MW for each for 2nd stage. A dam foot power house was also constructed which is used electricity by the water which is discharged from the koyna dam for irrigation purpose.it has two Francis turbine units of 20 MW each. the combined installed capacity of the two stages and the dam foot power house is 600MW.

In stage 3 this dam impounds the tail race water from stage 1 and 2. this water is drawn through penstock and electricity is generated by four Francis turbine units with a capacity of 80MW each. The tail race water from these stages then flows through a channel and joins the Arabian sea and Chiplun. The installed generating capacity of this stage is 320MW.

In stage 4 the water in head race tunnel is directly drawn from the reservoir and delivered to the head surge tank .then 4 pressure shafts takes the water downward vertically .the four huge Francis turbine units of 250MWeach generate electricity and tail race water is taken into the kolkedwadi dam reservoir through the tail race tunnel. The installed capacity of the stage along is 1000MW.this stage is mostly used to cater for the peak hour demands of the electric grid. The cross section of the FEM model of koyna dam .the nonlinear time history analysis is performed ,and to account for material non linearity in the problem ,the popular concrete damaged plasticity model and microcolumn failure model is used for dam and foundation respectively[4].



This indicates the live water storage percentage of koyna dam that indicated in grey colour between 15 June 2019 to 8 Aug 2019[5].

As Maharashtra is facing a power shortage on account of rising demand and dip in power generation from thermal plants due to coal shortage, the Maharashtra Electricity Generation Company Limited is now heavily dependent on the Koyna hydro-electric plant at Pophali near Chiplun. the power capacity is 1960 mw. The water resource development has delivered by 10TMC(thousand million cubic feet)water from koyna dam for hydro power generation to ensure the state does not face power cuts in next two months .the demand of electricity peaks in the month April and May .since September and October last year ,the thermal power plants are facing a shortage of coal .the central power ministry had asked the state to run the hydro power station at full capacity[6].

POWER AND WATER DISTRIBUTION:

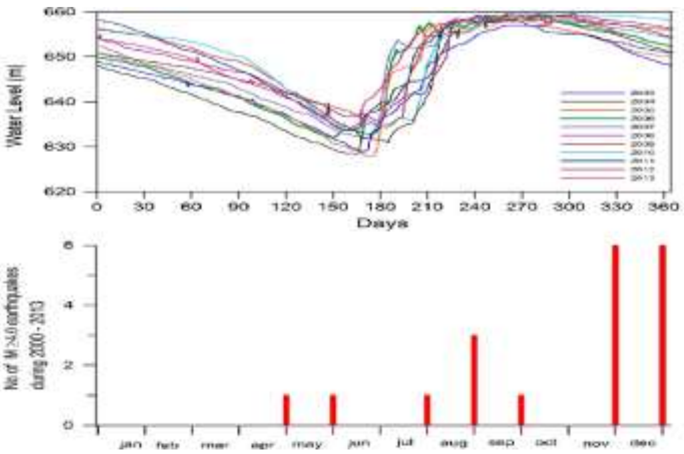
The main purpose of the dam is to provide hydroelectricity with some irrigation facilities in neighboring areas. There will 1960MW of power distribution to the various industries, agriculture and household purpose. The Koyna dam supplies water to west Maharashtra as well as to the hydroelectric power to neighboring areas. The dam plays a vital role in flood control in monsoon season. The catchment area dams the **Koyna River** and forms the **Shivsagar Lake** which is approximately 50 km in length. Koyna **Wildlife Sanctuary** covering an area of around 423.55 km2[7].

Dam safety and risk analysis:

Dam safety based on risk analysis methodologies demand quantification of the risk of the dam-reservoir system. This means that, for a given initial state of the system, and for the several failure modes considered, it is necessary to estimate the probability of the load events and the conditional probability of response of the system for a given load event, as well as estimating the consequences on the environment for the obtained response of the system. Dam-reservoir systems have a complex behaviour which has been tackled traditionally by simplifications in the formulation of the models and adoption of safety factors. Some of the analysis factors like

Description of the space of analysis: The methodology for estimating probabilities of failure proposed in this paper requires a preliminary clarification of the term ‘‘analysis space’’, i.e., the current state of knowledge in the two following fields: on the one hand, the methods of structural analysis for dams and, on the other hand, the mathematical models of structural reliability analysis

Proposed methodology: It is considered that its application to any other type of dam and for any other failure mode, particularly for those of essentially ‘‘structural’’ nature, can be carried out rather straightforwardly due to its generic formulation. These are some and risk analysis is also done by previous cases like landslides and earth quakes[8].



The first graph between water level and number of days

The second graph between earth quack and months in a year[9].

Srisailam Hydro power plant

The Srisailam Dam is constructed across the Krishna River in Nagar kurnool district, Telangana and Nandyal district, Andhra Pradesh near Srisailam temple town and is the 2nd largest capacity working hydroelectric station in our country. Srisailam Dam, Officially Called The Neelam Sanjeeva Reddy Project, Is A Dam Constructed On The Krishna River. It Is Sandwiched Between Jog Lamba Gadwall District, Telangana and Kurnool District, Andhra Pradesh. Srisailam Dam Structure Srisailam Dam stands at a height of 300 meter above sea level. It has a height of around 145 meters and length of 512 meters. There are 12 radial crest gates in Srisailam Dam. It can hold around 178.74 Tmcft and up to water level of 885 feet. The left bank underground power station houses 6 × 150 megawatts (200,000 hp) reversible Francis-pump turbines for pumped-storage operation (each Turbine can pump 200 cusecs). The right bank semi underground power station houses 7 × 110 megawatts (150,000 hp) Francis-turbine generators. Tail pond weir was completed during the year 2017 and pumping mode operation is being done Tail Pond dam/weir located 14 km downstream of Srisailam dam . Srisailam dam Is under advanced stage of construction to hold the water released by the hydro turbines and later pump back into the Srisailam reservoir by operating the turbines in pump mode. The weir portion got breached in November 2015 unable even the downstream Nagarjuna Sagar reservoir water level is below 531.5 feet (162 m) MSL. The tail pond has nearly 1 tmcft live storage capacity.[10]

Fig: Srisailam Dam

Sources of vibrations:

Vibrations are most dangerous stresses of an HPS, which occur during the sudden opening or closing of wicket gates. Analysis of vibration transients of an existing HPS prevents harmful resonances those occurred at a plant and hence reliability/availability of the equipment is increased.

In HPS, online vibration monitoring is done for various parts of HPE including relative shaft vibration, bearings absolute vibration, turbine cover vibration, thrust bearing axial vibration, stator core vibrations, stator bar vibrations, stator end winding vibrations.To dynamically monitor the motion of the generator/turbine shaft relative to the bearings “non-contact capacitive proximity probes” are usually used. Generally, these probes are insensitive to electrical run-out, magnetic field and shaft mechanical surface imperfections. Fault detection techniques and vibration signal processing are the other techniques which can be greatly discussed and under study.Excess vibrations cause wear & tear along with fatigue failure of guide vanes, runner blades, rim, bearing, shaft seal, shaft, runner labyrinth, Loose or shear nuts, wedges, stampings, bolts, pole wedges etc. at affected locations.[11]

SOURCES OF VIBRATION:

Generally, the main sources of vibration are:

- Electrical vibrations
- Mechanical vibrations

- Hydraulic vibrations

Vibrations occurs in – Rotating equipment Non rotating equipment

REASONS OF VIBRATIONS IN ROTATING EQUIPMENT:

Mainly in turbine and rotor vibrations in occur

In turbine runner-

mechanical imbalance, hydraulic imbalance, misalignment, cavitations, turbine bearing instability (due to rubs & hydraulic forces), rough zone operation, improper lubrication of mechanical parts, defective bearings, breakage of wicket gate linkage, cracked or chipped blades and shaft.

In rotor-

Same as runner but rotor rubs are the additional vibrations.

REASONS OF VIBRATIONS IN NONROTATING EQUIPMENT:

- Draft tube: Cavitations, Power Swings and Draft Tube Resonance
- Seal erosion: Depends on water quality.
- Penstock resonance: Cavitations
- Generator: Electromagnetic force
- Transformer: Magneto motive forces

Vibration on rotating hydro generating equipment:

Vibration of motor are classified as

1. Mechanical
2. Aerodynamic
3. Electro magnetic

Mechanical problems due to:

- Imbalance
- Misalignments
- Winding damage due to mechanical shock
- Defective bearings
- Looseness
- Soft-foot, impact or fretting etc

Aerodynamic problems due to:

- Discrete blade passing frequencies
- Resonant volume excitations with in motor
- Ventilation fans
- Broadband turbulence etc

Electromagnetic problems due to:

Imbalanced electromagnetic forces on the rotor and stator. Imbalance is due to air gap eccentricity, broken rotor bars, unequal distribution of air gap flux, inter-turn faults, shorted or open stator and rotor windings, unequal phase currents, magnetostriction and oscillations of torque

Relation between electrical supply frequency and rotational frequency can be expressed mathematically as shown in equation

$$fe = \frac{fs \times P}{2}$$

f_e is electrical supply frequency

f_s is shaft rotational frequency

P is number of magnetic poles.

Fig:Turbine cavitations due to vibrations

VIBRATION MONITORING AND MEASUREMENTS

VCM technique is very useful for timely identification of the fault due to excessive vibrations.

Dial gauges were used for vibration measurement; but they did not give a complete idea of shifting of shaft position or motion of shaft center lines under different operating conditions.

Vibrations of HPS are corresponding to pumping, turbine rough operating zone, turbine up thrust place, reciprocation to resonance effects, imbalanced air gap, changes of bearing oil viscosity, mechanical distortion effects, or any integration of these all.

Signal acquisition and processing is required to distinguish the vibration fault in HPS equipment.

Condition monitoring and fault diagnostics are involved with the following steps.

- Signal acquisition.
- Signal analysis.
- Signal storage.
- Data transfer and storage
- Data selection

A RADIOTRACER STUDY ON FLOW PATH OF SEEPAGE IN THE COFFER DAMS AT SRISAILAM

During monsoon season, the waterflow in the river is approximately 30000 m^3/sec. Due to this, dam integrity may compromise at micro-level. So, we will need to identify the possible seepage pathways inside the dam and should take necessary measurements to protect the dam's structure.

In the response of this, a radiotracer study was proposed to investigate:

(a) the points of entry of seepage water from the downstream side of the downstream coffer dam, and (b) the actual flow path of seepage water across the structure of the dam or through other areas.

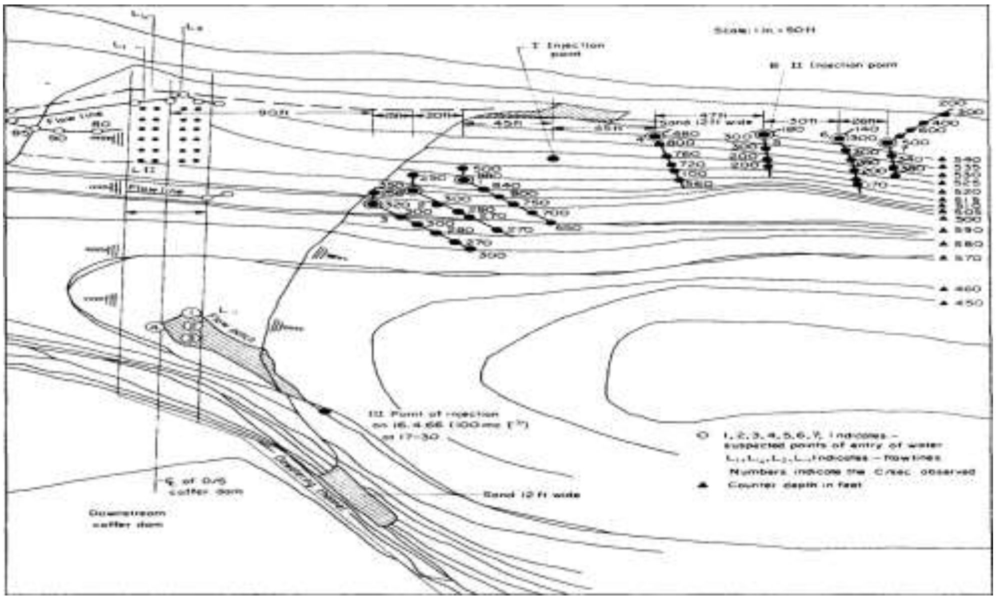
Selection of the radiotracer and of techniques [12]

Radiotracers are used to study the seepage in many ways.

One approach is to mix pure ɣ-emitting isotope like tritium in the form of tritiated water to the downstream near the bank of the river and monitor for the tracers by collecting the samples of water repeatedly from ponds and boreholes.

A second approach is to add a ɣ -emitting isotope in a suitable chemical form which would remain in solution or in suspension in the water but would be filtered by the material at the point of maximum seepage.

A third approach is to use a high energy ɣ-emitting radioisotope added to the water in a chemical state, such that it will dissolve freely with the water and will not be adsorbed in the soil during seepage.



The tracer was first observed in the pond 6 hr and 40 min after the first injection. On the assumption of a straight path between the points of entry and of exit in the pond, a flow speed of 10 m/hr was calculated. However, this assumption might not be quite correct. Also, during the period of observation of the tracer, after the first injection, the differential head of water across the dam was very small, of the order of 4-5cm (0.15f t) and this was responsible for the slow movement of the tracer.

Power generation optimization:

At present the initial inflows into Srisailam reservoir are stored excessively without using for power generation.

The flood water fills the remaining empty Srisailam reservoir quickly and most of the flood water overflows into downstream Nagarjuna Sagar reservoir without being used for power generation.

Srisailam reservoir, serving as lower level reservoir, has potential to install nearly 77,000 MW high head pumped storage hydroelectric power plants on its right side.

The breakup of renewable energy sources (RES) is:

- Solar power (57,973.78 MW)
- Wind power(40,893.33 MW)
- Biomass/Cogeneration (10,205.61 MW)
- Small hydro (4,887.90 MW)
- Waste-to-energy (476.75 MW)[13]

Dam safety:

- Other hazards associated with hydropower power projects include drowning around the project (because of the new reservoirs) or downstream of the
- project (users of the river) A passer-by could also drown because of the water discharging in from the tailrace during normal or emergency events.
- Other risks are associated with water diversion structures, water intake structures, and other project infrastructure (that is, surge shafts). Prevention strategies that should be evaluated in project design include:
- Education campaigns to sensitize community residents about the risks of drowning in the reservoir, tailrace, or downstream river system.
- Warning signs along the shore of the reservoir.
- Warning signs and alarm or community warning systems along the tailrace or in downstream areas subject to sudden water level fluctuations and

- Access control (fencing) to prevent access into high-risk areas.[14]

Medium Head Hydro Power Plants(30-300m)

Water head height range between 30-300m is regarded as medium hydro power plant.

China's Yangtze Three Hydro Power Plant:

Three Gorges, dam on the Yangtze River just west of the city of Yichang in Hubei province, China. When construction of the dam caused the displacement of 1.3 million people and the destruction of natural features and countless rare architectural and archaeological sites. Height of dam is 185 metres (607 feet). Storage 39.3 billion cubic meters of water (51.4 billion cubic yards). Sluice gates to discharge flood water after heavy rains pushed water levels to the limit.[15]

Turbine Used:[16]

Power in the dam is generated by 32 Francis turbines with each turbine producing 700 MW of energy. Efficiency of the turbines averages over 94%. Francis's turbines operating at partial load present pressure fluctuations due to the vortex rope in the draft tube cone. This phenomenon generates strong vibrations and noise that may produce failures on the mechanical elements of the machine.

Researcher	**Experiment**	**Result**	**Remarks**
Schweiger, Lugaresi and Massa	Parameters under specific speed and cavitation in Francis's turbine	Efficiency of Francis Turbine is at highest possible rate around (90-93%)	Use the governor to control the positions of the gates so as to maintain the turbine at constant speed
Thapa	Studied about erosion problems	Due to unsteady flow of water. He observed that the efficiency of the turbine decreases with the increase in erosion.	Erosion resistant coating materials in hydraulic turbine sprayed with tungsten carbide cobalt chromium

Problems Faced by China During Installation[17]

Sedimentation:

At current levels, 80% of the land in the area is experiencing erosion, depositing about 40 million tons of sediment into the Yangtze annually. Because the flow is slower above the dam, much of this sediment will now settle there instead of flowing downstream, and there will be less sediment downstream.

Waste Management:

According to the Ministry of Environmental Protection, as of April 2007, more than 50 new plants could treat 1.84 million tons per day, 65% of the total need. About 32 landfills were added, which could handle 7,664.5 tones of solid waste every day. Over one billion tons of wastewater are released annually into the river, which was more likely to be swept away before the reservoir was created. This has left the water looking stagnant, polluted and murky.

Wildlife:

Freshwater fish are especially affected by dams due to changes in the water temperature and flow regime. Many other fish are injured in the turbine blades of the hydroelectric plants as well. This is particularly detrimental to the ecosystem of the region because the Yangtze River basin is home to 361 different fish species and accounts for 27 percent of all endangered freshwater fish species in China. Other aquatic species have been endangered by the dam, particularly the baiji, or Chinese river dolphin, now extinct. The Chinese paddlefish is also extinct in part due to the dam blocking its migration

Power generation, capacity and distribution:[18]

The main generators weigh about 6,000 tones each and are designed to produce more than 700 MW of power. The designed hydraulic head of the generator is 80.6 meters (264 ft). The flow rate varies between 600–950 cubic meters per second (21,000–34,000 cu ft/s) depending on the head available. the generator rotors have 80 poles. Power is distributed over multiple 500 kV transmission lines. Three direct current (DC) lines to the East China Grid carry 7,200 MW: Three Gorges – Shanghai (3,000 MW), HVDC Three Gorges – Changzhou (3,000 MW), and HVDC Gezhouba – Shanghai (1,200 MW). The alternating current (AC) lines to the Central China Grid have a total capacity of 12,000 shas a capacity of 3,000 MW.

Dam safety:

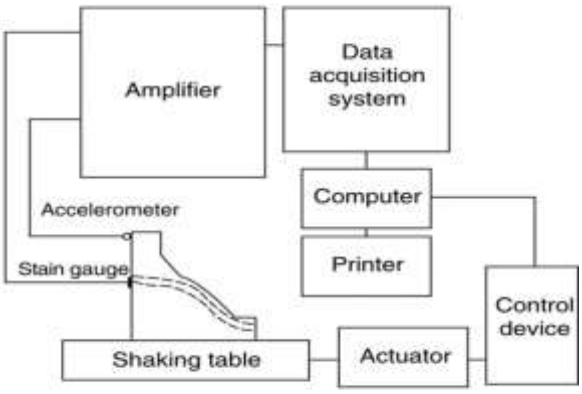
Instrumentation achieves these objectives by providing quantitative data to assess groundwater pressure, deformation, total stress, temperature, seismic events, leakage, and water levels. Total movements as well as relative movements between zones of an embankment and its foundation may also need to be monitored.

Risk Analysis:

In 2005, NASA scientists calculated that the shift of water mass stored by the dams would increase the total length of the Earth's day by 0.06 microseconds and make the Earth slightly more round in the middle and flat on the poles.

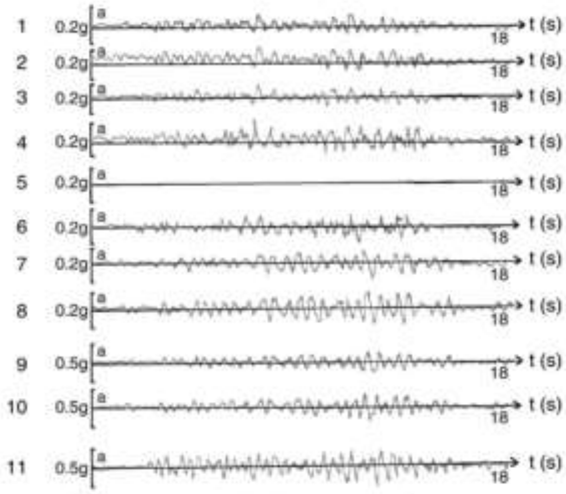
Experimental investigation on 3 gorges plant:[19]

A model test of the powerhouse monolith at a geometric scale of 1:100 is carried out on a shaking table to investigate the seismic response of the structure. Analysis is made for the case of an empty reservoir and rigid foundation. The whole site area belongs to a slightly seismic area, ranking at degree 6 of seismic intensity as classified by the state authority department concerned. However, according to the seismic design codes of China, for the Three Gorges dam—such a large and very important project—it is required to raise the seismic intensity to one grade higher than that of the local region. Therefore, the seismic intensity of degree 7 as specified in should be considered for the earthquake-resistant design of the Three Gorges dam.



Due to the limitation of space on the shaking table and the difficulty of satisfying the similarity law using water in the model test, the interaction between water and the dam was not considered in the model test. In other words, the cases where the reservoir is empty and the foundation is rigid were considered in the model test. In the test, the dam model was fastened to the shaking table, and the seismic accelerograms were input into the control device of the shaking table. The shaking table vibrated according to the input seismic records, simulating the earthquake excitations on the ground. Measurements were made to obtain the responses of acceleration and strain at the measuring points.

Test results:



(a) Acceleration responses for the Three Gorges accelerogram.

The results of this research also show that the powerhouse monolith of the Three Gorges dam has a relatively high capability for earthquake resistance and could guarantee the safety of the dam under seismic action with a seismic fortification intensity of degree 7, as defined in the seismic design code of China.

Nagarjuna Sagar Hydro Power Plant:[20]

It was constructed between 1955 and 1967, the dam created a water reservoir with gross storage capacity of 11.472 billion cubic metres (405.1×109 cu ft).Its effective capacity is 6.92 cubic kms.The dam is 490 feet (150 m) tall from its deepest foundation and 0.99 miles (1.6 km) long with 26 flood gates which are 42 feet (13m) wide and 45 feet (14 m)tall .Out of 111 meters of height of the dam above ground level the quantity of masonry for 35 meters height amounts to half. So, it was felt that manual lifting of materials up to 35 meters was planned. This is really a marvelous feat very much appreciated by outside visitors, especially by foreign visitors.[21]

Methodology :

The Flow Health (FH) method, which is conceptually based on the Range of Variability Approach (RVA), is used to calculate the degree of departure from the natural flow regime due to the dams.

Gates used:

It protected with 26 gates measuring 124.663m in height, Nagarjuna Sagar Dam located in Nalgonda District is built across River Krishna .The dam has a storage capacity of nearly 11,472 million cubic meters with an irrigation capacity for 9.81 lac acres of land. The dam measure 150m tall and 16 kms in length while also being a major tourist attraction. In fact, it is among the first irrigation projects started by Indian Government as an element of Green Revolution.[22]

Turbine used:[23]

The Francis turbine is a type of water turbine. It is an inward-flow reaction turbine that combines radial and axial flow concepts. Francis's turbines are the most common water turbine in use today, and can achieve over 95% efficiency.

Power Generation:

The hydroelectric plant has a power generation capacity of 815.6 MW with 8 units .First unit was commissioned on 7 March 1978 and 8th unit on 24 December 1985.The right canal plant has a power generation capacity of 90 megawatts (120,000 hp) with 3 units of 30 megawatts (40,000 hp) each. The left canal plant has a power generation capacity of 60 megawatts (80,000 hp) with 2 units of 30 MW each. Draws water from the Nagarjuna Sagar reservoir to irrigate 0.37 million acres (1,500 km2) of land in Nalgonda district.[24]

Catchments Of Pollutants:

The various pollutants and its mobility in the catchments of Nagarjuna Sagar dam built on the Krishna river is of utmost important .As the Pedaguttu and Lambarpur catchments area has a proposed Uranium mining sites and Nagarjuna Sagar dam is the third largest man-made dam which is the ultimate destination of all the rivulets in the Pedaguttu catchments.

Table: Transport Parameter of some famous catchments

S.N.	Catchments	Transport coefficient (yr^{-1})	Residence Time (year)	Reference
1	Mississipi	0.00039	2580	[14]
2	Alpine Rhone	0.000072	1400	[10]
3	**Nagarjun Sagar Dam water reservoir**	**0.000027**	**4166**	**Present study**

Methodology for water management:

The Nagarjuna Sagar left canal, known as the 'Lal Bahdur Canal,' runs for 180 kilometers as the main canal and another 117 kilometers as the 21st main branch canal (21st MBC).As a result, the overall length of the main canal plus the 21st Main Branch canal is 297 kilometers. Its irrigation for 4.20 lakh ha (10.39 lakh acres) of planned ayacut in the Surya pet, Nalgonda, and Khammam districts in the state of Telangana .Krishna in Andhra Pradesh, using 132 TMC of KWDT-allocated water. It has distributary network with 7 branch canals totaling 7,722 km in length and field total length of 9,654 kilometers of canals.[25]

Impact of the Adaptive Research Demonstrations:

The trainee farmers have in turn speeded the usefulness of these demonstrations in terms of saving the irrigation water by practicing micro-irrigation (drip, sprinkler and fertigation) in different fields and introducing new technologies and further the resource conservation and allied crop protection practice.

Small Hydropower Plants

Small hydropower plants are less than 50 megawatts(MW).Many countries are also working to increase the hydropower capacity and in the year 2018 Forty-eight countries added hydropower capacity among which China has the highest new installed capacity of 8,540 MW[26]

Small hydropower in India

India is a country with 1.35 billion population and third largest electricity energy consumer in the world after China and US. According to Key World Energy Statics 2019, India is the third largest producer of electricity in the world with the generation of 1,561 TWh. Although power generation has stretched more than 100 times since independence in 1947, the energy demand is ever increasing due to accelerating economic activities

Classification Of Small Hydro In India

Class	**Station Capacity in KW**
Micro Hydro	Up to 100
Mini Hydro	101 to 2000
Small Hydro	2001 to 25000

Civil Work Design Issues

During rainy seasons the water becomes violent and carries lots of sediment & boulders with it. These boulders and sediments effect the turbines; hence the hydro power project has to be closed during the seasons of high discharge. The solution of this problem is providing sediment traps so that sediments and pebbles do not enter into the turbine system. Plant outage factor comes out to be 30%. In this site, there is a constant problem of penstock damaging as boulders from the hills fall on it during the rainy season.

Issue In Electro-Mechanical Works And Maintenances

As the site in remote area maintenance of the different parts of the power plants is difficult and it takes more time for swapping the parts to town . Machine operation is affected due to lack of trained operator. In the snowfall time, cables are broken due to overweight of snow. The maintenance in those areas is very difficult. Due to the lack of electricity(4) .

Problems with dams

- Dams block the annual migration of fish
- Fish population decline
- Water temperatures increase
- People residing in village and towns in the nearby area, where these are chances of flooding, they loss their businesses

Safety of dams

- The department categorizes a small dam to be less than 10 metres in height and storing less than 1,500 megaliters.
- The human or the nature causes of dam failure include poor design and construction improper maintenance.
- Storms,earthquakes,winds and other natural causes could compromise the strength of a dam and also cause a dam to fail

Investment costs

Direct costs comprise: civil, electro-mechanical equipment and power transmission line costs. Civil costs include the construction and hydro structural costs as well as dam conveyance of water system, penstock structure, a head pond, the forebay, the power house, tailrace structure, the access and any future unpredicted costs. No standard cost unit is given to the civil work. The cost varies with sites depending on the topography and the geology, and the construction method applied and the materials used. Electro-mechanical costs include costs met on turbines, generators, governors, gates, control systems, a power substation, electrical and mechanical auxiliary equipment, etc. The electro-mechanical equipment cost accounts for about 30–40% of the total small hydropower plant budget[5]. Indirect costs are engineering and design (ED), supervision and administration (SA) as well as inflation costs at period of construction. However, ED depends on type; size as well as location of the plant site, as SA (i.e., expenditures on land, management, inspection and supervision) it is also calculated as a percentage of the construction cost. Generally, the operation and maintenance costs without major replacements are estimated to be between 3–4% of the capital cost. Hydro-power plants have got high capital costs but low maintenance costs.[27]

Micro Head Hydro Power Plant:

Micro hydro power plant is to generate the electricity with the Flow water through the turbine .then the rotational motion of The turbine is converted in the electricity. This power plant is Sustainable through a long time .which is easier to generate The electricity .these type of power plant which is suitable for The hilly areas and the canals.

Development of helical hydraulic turbine:

The dam's construction is not possible then gorlov turbine used. A Gorlov turbine can capture 35% of flowing water energy. Gorlov helical turbine is best suited for use in rivers or streams where the construction of a dam is not possible From an environmental point of view, not constructing a dam has less impact on the existing natural environment. Gorlov has lab tested turbines attached to barges in the Cape Cod Canal tidal current with no harmful effect on fish.

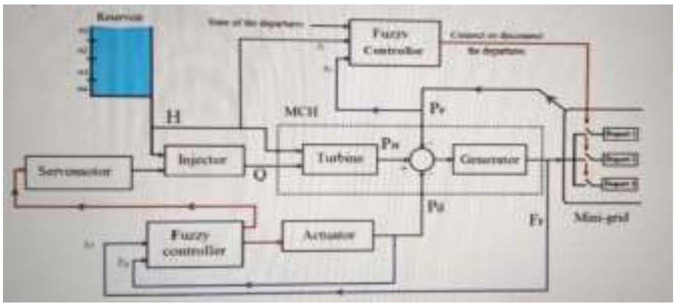
Fuzzy logic control for load frequency:[28]

Fuzzy logic controller system used in micro hydro power plants: The fuzzy logic is an important technology and a successful branch of automation and control theory, which provides good results in control of power system. This paper aims to use fuzzy control to insure good control of isolated MHPP. The proposed control scheme is suitable for turbine systems with both guide vane governors and synchronous generators, especially permanent magnet machines which have no automatic voltage The presented fuzzy logic controller has three main tasks:

1)It regulates the frequency output of the plant in spite of changing user loads.

2) it limits the waste of the available water.

3) it manages the electricity distribution by dividing the mini network on different departures connected in order of priority the fuzzy logic has been developed to be used for its ability to easily incorporate human expertise, the proposed scheme.



Failure of dams :

A dam failure is a catastrophic type of structural of failure. characterized by the sudden, rapid, and uncontrolled release of impounded water such an uncontrolled release. Between the years 2000 and 2009 more than 200 notable dam failures happened worldwide.

Main causes of dam failures:

1.Spilway design error

2.Earthquakes

3.Extreme in flow of water.

5. Poor maintenance, especially of outlet pipes.

A Micro Hydro Power Generation System for Sustainable Micro grid Development in Rural[29]

In micro hydro power plant are the main sources to generate electricity by water source. Generation of system for sustainable micro grid development in rural areas . We should estimate the area to construct the micro hydro power plant . It is necessary to have an own way to generate the micro hydro power plant.

- Water Turbine
- gear box
- Blades of Water Turbine
- Blades of Water Turbine

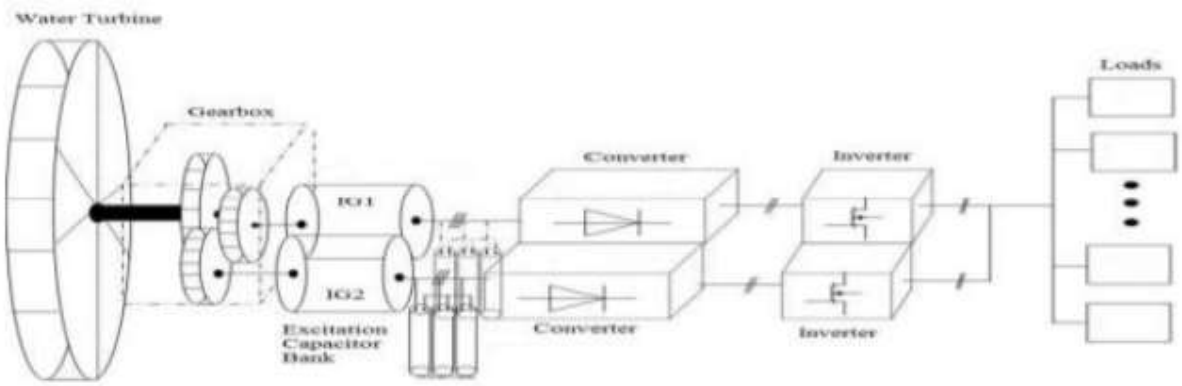


Fig : method for suitable to generate the power

Micro hydro plants are becoming one of the reliable sources to Meet energy demand especially in rural areas where expanding National grid is not feasible both technically and commercially. Such plants are mostly being operated in stand-alone mode. These plants have a common problem of very low utilization of Electricity generation during off peaks hours resulting in the Low plant factor. Using a Micro-Grid (also called local grid), the issue of loss Of plant efficiency as a result of under-utilization of electricity Generation during off peak hours can also be[3]addressed. This Can also open the prospects for more business and cottage Industries in rural areas and promotes further commercial .Activities to support sustainable rural development.

Electronics play a major role in micro hydro powerplant

- Such has a turbine and micro grid have best chance to develop the power generation .
- Electronic controller is the best way to control the loads generate in the micro hydro power plant .
- Micro hydropower plants are seasonal way to generate the power more become the force of water leads to speed up the turbine to get the power more efficiently

Conclusion :

Hydropower plants are a vital energy source to the world. Water is an efficient and reliable fuel. The use, creation, and expansion of power plants should continue being pursued.

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