Case study of Pumped Storage Hydro Power Plant at Ghatghar

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Abstract

The main part of the Ghatghar Pumped storage plant is the dam built with RCC technology having a capacity of 250 MW. The plant has three dams, that include the saddle dam, the upper dam, and the lower dam, all of them are built with roller compacted concrete technique. A lot care was taken while building the dam for safe and quality work , for that expert opinion was taken from the peoples who had worked on such type of plant. The biggest task was to design the layout, erect and commission aggregate crushing plants, RCC cooling system, and RCC production and delivery place. The major equipments used for RCC placement consists of double axle 20 t dump trucks, truck unloader, stacker conveyor, small double drum roller, high frequency needle vibrators, high pressure water blaster, and mechanical brooms. The key for fast, efficient, economic, and high quality way of construction of dams of any size and numbers is RCC. The most care was also taken for the relocation of the villages for the construction purpose.

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I. INTRODUCTION

Now a days as we all know energy crises is becoming a challenge as our energy demand is increasing day by day. The reduction in fossil fuel energy and the environment condition is worsening day by day. This reduces global economic and social development. So now a days various types of energy sources are used to make the demand and source at a level[1]. Renewable energy sources is one of the best source to be used because of its advantages. Solar, wind, Tidal, Ocean, hydro are few of the types of renewable sources that are being used now a days. Government of INDIA is also very keen to increase the usage of renewable energy sources and has launched various schemes to attract common people to increase the usage of renewable energy sources.

The technology behind hydro pumped storage plants is well-established and has been used for over a century.

After making efficient use of energy, pumped storage plants (PSPs) have traditionally monetized their operations by continuously purchasing and selling energy[2]. In India, hydroelectric facilities are considered small hydro if their total installed capacity does not exceed 25 megawatts (MW), with further sub categorization into "micro" (100 kW), "mini" (2 MW), and "small hydro" (25 MW). Prior to 1989, hydropower was regulated by the Ministry of Power with the assistance of state electricity boards. In 1989, the government transferred responsibility for hydroelectric projects with an installed capacity of 3MW or less to the Ministry of New and Renewable Energy (MNRE). The Ministry has made several steps for the advancement of microhydro. For example, the India-Renewable Resources Development Project with the International Development Association (IDA) aims to build 100MW of small hydro power plants based on canals with the help of private sector investment. In a similar vein, the

MNRE was given responsibility for plants of a 25MW capacity or less in November 1999.

Putting Pumps Away Electricity from hydropower plants is reliable and widely available. When in generating mode, water from the higher reservoir turns a turbine, which in turn spins an electric generator, which produces power and feeds it into the grid. The generator switches roles and becomes a motor in consumption mode, using power from the grid to move water from the lower to the upper reservoir[3]. The supplementary usage of hydropower systems is enhanced by the pumped storage power plant's many benefits, such as load management, frequency modulation, and emergency power supplying capacity[4]. Francis turbines, Kaplan turbines, Bulb turbines, and Pelton turbines, just to mention a few, are only some of the types of hydro turbines used to generate hydroelectricity. Among the several types of hydraulic machinery used in renewable energy systems, Francis pump-turbines are by far the most common[5].

Land in the village of Ghatghar, taluka of Akole, district of Ahmednagar, is being purchased for the construction of the Upper Dam, Saddle Dam, Approach Channel, Road, Quarry Gaothan, etc. From the 177.86 ha of privately owned property and the 12.09 ha of forested land, a total of 189.95 ha is gained.

Second, property in Chondhe Village, Tahsil Shahapur, District Thane was purchased for use in the construction of Lower Dam, Roads, the Quarry, the Colony, etc. We bought up 80.146 hectares of private property and 50.00 hectares of woodland for a grand total of 130.146 hectares. In all, 320.096 hectares of land are purchased, with private property accounting for 258.006 hectares and forested land accounting for 62.09 hectares..

II.HISTORY OF PUMPED STORAGE POWER PLANTS IN THE WORLD

For past thousands of years society has managed to used water for its use, in the history from Roman to Egyptian irrigation techniques. In hydro power is the conversion of kinetic and potential energy into electricity. Firstly hydro power was used for generation in the year 1880 followed by U S hydropower plant on the Fox river. Very first pumped hydro plant was used in Italy and Switzerland in early 1890. The Rocky River pumped hydro plant was first opened in Connecticut in 1929. In 1993 reversible pump turbines were available in ample quantity[6].

III. CONSTRUCTIONAL DETAILS OF THE PROJECT

Ghatghar Pumped Storage power plant is the largest pumped storage plant in the Maharashtra state. It is located on the river Pravara which is on the outskirts of Thane and Ahmednagar district in Maharashtra. The main idea behind this is to meet the increasing demands due to the industrial and population growth in the state of Maharashtra.

The capacity of the plant is 250 MW. The plant consist of two reservoirs, the first is Upper reservoir located at village near Ghatghar, Taluka Akole, District Ahmednagar and the second is the lower reservoir which is located near village Chonde, Shahpur taluka, District thane. The underground power house is located near the lower reservoir. This power house consist of two reversible pump turbines each of 125 MW. This plant ensures annual generation of 497 Mus with a operating head of 400m. The plant operates 6hrs daily for generation during peak hours excluding Sundays and operates 7hrs for pumping during off-peak hours excluding Sundays.

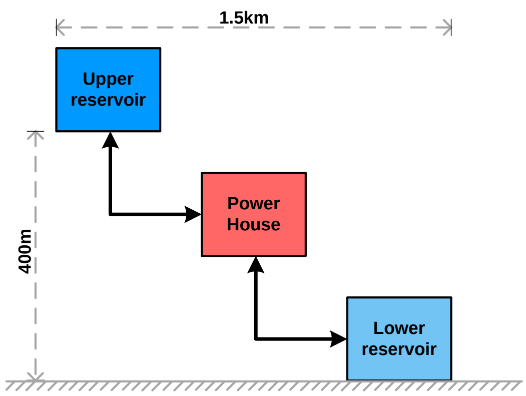

Fig.No 2 Block Diagram of the system

a. Location

Because this is a pumped storage plant, it occupies two locations. Upper reservoir is near Ghatghar village in Taluka Akole, District

Ahmednagar; lower reservoir is close to Chonde village in Shahpur taluka, District Thane.

Thane District's lower dam may be found on Shai nalla, not far from the village of Chondhe in Shahapur Tahasil. Its length is 446.80 metres and its maximum height is 86.14 metres above the deepest foundation level. The dam can hold up to 3.21 MCM. The total length of the spillway is 89m, and its discharge is 192.38 m3/sec. In terms of distance from other major cities, the plant is located 80 kilometres from Mumbai and has a seaport located another 80 kilometres away.

Fig.3 Lower Dam

The village of Ghatghar in Akola Tahsil, Ahemadnagar District, is close to where the Upper Dam on the Pravara River is situated. The dam has a total storage capacity of 5.82 MCum. The dam is 503 metres in length and stands at a maximum height of 15,165 metres above the deepest foundation level.

Fig.4 Upper dam

III. COMPONENTS OF THE PLANT

This plant consists of an upper dam, a saddle dam, an upper intake approach channel, an upper intake structure, a pressure shaft, an underground power house complex, a tail race tunnel, a tail surge well, a lower intake structure, a lower intake approach channel, a lower reservoir, and a lower intake structure.

a. Dam

Dam consist of two different reservoirs separated by 1.5 Km. Upper dam and lower dam were constructed with new RCC technology for fast construction. The main features of the dam are given as , Saddle Dam is 11.5 meter in height, 286 meter in length and lower dam is 86.14 meter in height , 446.80 meter in length.

b. Power House Complex

The power house in this plant consist of two turbine generator units and two three phase transformers respectively. Two ancillary buildings flank the main machine hall of the power plant complex. It's made up of many corridors, including a cable passage, bus ducts 1 and 2, and an emergency route that connects the transformer hall to the machine hall.

c. Auxillary Blocks

The powerhouse has two auxiliary blocks, one on either side of the central hall, as was previously indicated. With dimensions of 29 x 22.20 x 23.80 m, auxiliary block No.1 may be found on the service bay side of the building. Located on the V.T. side, auxiliary block No.2 has the following dimensions (excluding the sump pit): 19.475 x 23.40 x 24.80 m.

d. Transformer Hall

The dimensions of the hall are 81.35 metres in length, 20 metres in width, and 26 metres in height from the floor of the service bay. As was previously indicated, a corridor connects the transformer hall to the machine hall.

e. Tail Race Tunnel

Having a diameter of 6.00 m, the concrete-lined Tail Race Tunnel is 590 m in length. Construction of two concrete plugs at the junction of the Link Tunnels and the Tail Surge Well are among the TRT's many projects.

f. Water Conductor System

A steel walled pressure shaft of 696 m in length and 4.25 to 3.5 m in diameter makes up the Upper Intake Structure of the water conductor system. The Tail Race Tunnel measures 590 m in length, and the Lower Intake Structure is located at the end of the tunnel. TRT has a tail surge well with a diameter of 11 metres and a depth of 137 metres. Both the Upper and Lower Intake Structures have emergency exits installed. The Lower Intake emergency gate measures 5.27 x 9.25 metres in size and weighs 110 tonnes. It was completely built and installed by the Mechanical wing of the Water Resources Department of the Government of Maharashtra.

g. Turbine Unit

Guide vane assembly, G.V. mechanism, and installation. We have completed assembly of the servomotors, turbine guide bearing and Turbine shaft, and runner shaft seal. Oil pipeline and instrumentation are completed as well. The governor oil system has passed all pre-commissioning tests.

h. Butterfly Valve

The T.R.T. draining work and installation of BFV OPU unit (power pack) is completed. B.F.V. servomotor installation work is completed. Work of operational checks of B F V is completed.

i. Main Inlet Valve

Installation of MIV servomotor OPU and its connection with MIV is completed. Installation of MIV control panel and oil piping is completed. Operational checks of MIV are completed.

j. Motor Control Panels (MCC)

The MCCs of the air compressor system, the drainage pump for the head cover, the cooling water booster pump, the strainers for the cooling water, the drain pump, and the sand separator have all been installed. The governor control panel and shaft seal are finished.

k. Generator unit

All necessary components, including the lower bracket, stator, upper bracket, upper thrust and guide bearing, air coolers, rotor lower guide bearing, brake jacks, brake dust collector, space heaters, slip ring brush gear assembly, and shaft current CT, have been installed. The shaft connection between the turbine and generator has been aligned simultaneously. The oil cooler and all of its associated plumbing has been installed for both the lower and upper guide bearings. The high-pressure lubricating pump and its associated pipework have been successfully installed.

l. Auxillaries

Control panels and D & D pumps are set up. All of the ACLT panels, which operate at 400 V, have been installed, and the SA-I and SA-II panels have been charged. There are four total transformers in the building, two for the main station and two for each individual unit. Three battery chargers and batteries operating at 110 volts D.C.

IV. IMPORTANT FEATURES OF WATER CONDUCTOR SYSTEM

This plant has various features which makes it different from other power plants , few of them are listed below.

a. Water utilization

Daily water utilization for power generation is around 1.607 mm3, design discharge is of around 74.80m3/sec. Also the water required for weekly generation is 2.346mm3.

b. Reservoir Data

The catchment area of upper reservoir is 18.43 Km2 and that of lower reservoir is 2.5 Km2. It has a dead storage of 0.68mm3 for upper reservoir and 0.48 mm3 for lower reservoir, live storage of 5.14mm3 for upper reservoir and 2.73mm3 for lower reservoir, with gross storage of 5.82mm3 for upper reservoir and 3.21mm3 for lower reservoir.

c. Upper and Lower Intake

The upper intake is open type R.C.C. Structure with 5/ bay trash rack & 3.90m * 7.27 m Service gate while the lower intake is also open type R.C.C. Structure with 5/ bay trash rack & 5.27m * 9.25 m Service gate.

d. Power House

Table No 1:- Power house details

Sr.no	Type	Underground
i.	Installation	250MW (2 x 125 MW)
ii.	Machine Hall (Auxiliary Block)	123.00m x 23.40 m x 46.80 m
iii	Transformer Hall	81.35 m x 20.00 m x 26.00 m

e. Tail race tunnel

The tail race tunnel is circular lined shaped, 590m in length and 6 meter in diameter.

Pump Turbine & Motor Generator

i) Pump

Table No 2:- Details of Pump Turbine Set

Type	Type Vertical shaft single runner single stage Francis type
Number of Units	Two
Elevation of pump-turbine center	260.00 m
Design Head (Turbine Mode)	410 m
Design discharge (Turbine Mode)	37.40 m^3/Sec
Design Head (Pump Mode)	430 m
Design discharge (Pump Mode)	30.40 m^3/Sec
Rated Speed	500 rpm
Direction of rotation	Clockwise (Turbine Mode)
Spiral case	Welded steel construction
Design pressure	68 Kgf/cm^2
Inlet diameter	1800 mm
Inlet center line offset	3670 mm
Runner	Francis type
No. of runner vane	7
Inlet diameter	3468 mm
Outlet diameter	1730 mm

ii) Motor-Generator

Table No 3:- Details of Motor Generator Set

	Generator	Motor
Output	147 MVA	150 MW
Voltage	13.8 KV	13.8 KV
Current	6150 A	6380 A
Frequency	50 Hz	50 Hz
Power factor	0.9	1.0
Speed	500 rpm	500 rpm
Direction of rotation	Clockwise	Counter clockwise
Daily hours generation	6 Hours (Except Sunday)	
Daily pumping hours	7 Hours (balance on Sunday)	
Energy generated	9.57 MUs/ week (497.43 MUS / year)	
Energy required for pumping	12.41 MUs / weekly (645.37 MUs / year)	

V. CONCLUSION

The plant came in operation since 2008.The reservoir capacity is 3.21 million cubic meter. The net head of the project is 400m. The plant generates 1.5 MUS daily and 469.5 GWh of electricity yearly. The plant operates 6hrs daily for generation during peak hours excluding Sundays and operates 7hrs for pumping during off-peak hours excluding Sundays.

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