Uri – II Hydel Power Project: A triumph of engineering resilience

A downstream view of the 52 m high concrete gravity dam at the Uri-II HEP on River Jhelum in Jammu and Kashmir

The government of Jammu and Kashmir is pursuing a massive hydel power expansion plan to add about 8,000 MW of hydel power capacity over the next decade. The objective is to optimally tap the hydro electric potential of the state and become not just energy independent, but also be an exporter of power. The Baglihar II, Uri II, Nimoo Bazgoo, Chutak and Kishanganga hydel power projects - which will have a total combined capacity of 1,959 MW - are part of Jammu & Kashmir's renewed emphasis on developing its hydel power resources.

The 240 MW Uri-II Hydel Power Project is a run-of-the-river scheme being executed by HCC for the National Hydroelectric Power Corporation (NHPC) on the Jhelum River in the Uri area of Baramullah District, in Northern Kashmir. This is the second project to be constructed on the Jhelum River and is a downstream development of Uri-I which is already in operation. Designed to lend further stability to the Northern Grid, the project will supply power to Jammu & Kashmir, Uttarakhand, Uttar Pradesh, Haryana, Delhi, Punjab, Rajasthan and Chandigarh.

Background

HCC had received the LOA for the Uri-II Project on September 21, 2005 and the mobilization activities were initiated subsequently. On October 8, 2005, a devastating earthquake measuring 7.4 on the Richter scale hit this region, resulting in massive damage to life and property in the area. All access roads to the work site got damaged due to landslides and mudflows triggered by this high intensity quaver. HCC had five teams trained by RedR at the Uri site. Their first action was to assess needs in one part of the disaster zone; then they opened roads to 21 villages and distributed basic necessities like, clothing, tents and shelter materials. About one-fifth of the $76,000 cost in staff time, equipment use and materials was covered by donations from HCC employees across India. During the second phase, HCC worked with an Indian NGO, SEEDS, to design and build several hundred temporary shelters in the 12 weeks before winter hit the disaster zone.

As a result of this disaster, initial project mobilization and start of the project was impacted for a period of six months. Despite this initial delay, the Uri-II project team remained steadfast in their efforts and application. The team achieved its second milestone of completion of the diversion channel on January 11, 2007, on the contractual date.

Project Details

The scope of work for the Uri-II project includes the construction of a concrete gravity dam, diversion tunnel, head race tunnel, surge shaft, pressure shaft, power house complex and tail race tunnel. The River Jhelum was channelised through a diversion tunnel having a diameter of 8.8 m and length of 337 m to facilitate the construction of the Concrete Dam. The total catchment area at the dam site is 13,400 km^2. The concrete gravity dam is 52 m in height and 157 m in length. The project's head race tunnel is 4.23 km in length and 8.4 m in diameter. Other structures include a restricted orifice type surge shaft of 25 m diameter and a 3.61 km long tail race tunnel. There are four spillways of nine metres each in the dam which will help divert the water to the tunnel for power generation. An underground power house 133 m in length, 15 m in width and 40 m in height will accommodate four turbines of 60 MW capacity each, which is anticipated to generate 1,123 million electricity units annually.

Unpredictable geology of the terrain

The project lies in the eastern part of the Kashmir syntaxial bend of the Northwest Himalaya and is occupied by quaternary deposits and sedimentary rocks of upper Murree Formation comprising sandstone, siltstone and shale sequence which are folded and faulted. In order to ensure the success of activities such as tunneling in

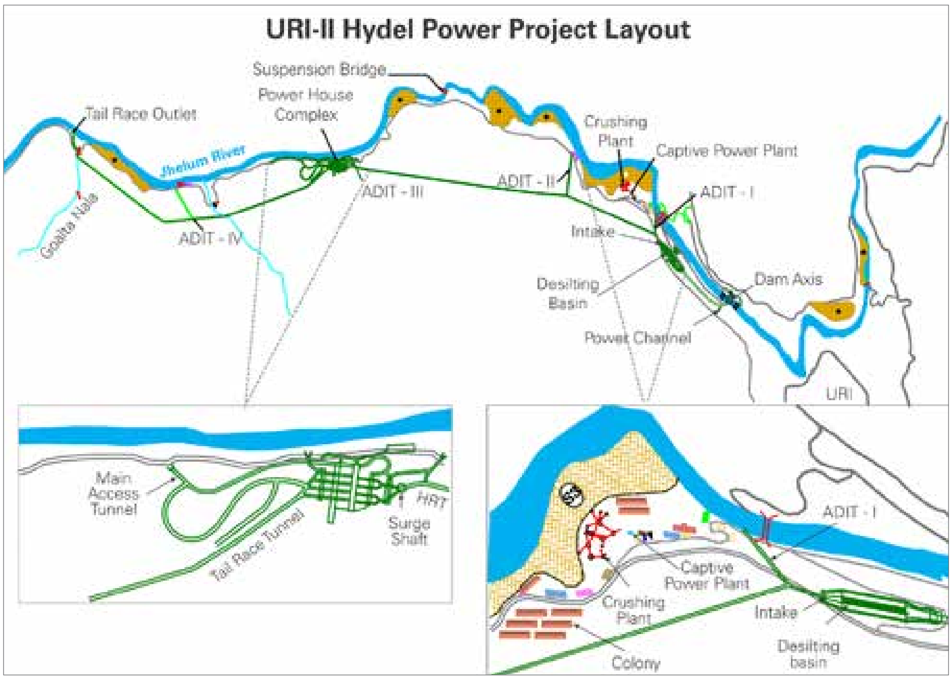
Excavation in progress at the head race tunnel

adverse geological conditions, the HCC project team carried out detailed investigations, and appropriate rock support (Wire mesh, Shotcrete, Steel Rib, Rock Bolt and Rock anchor) methods were used to safeguard against the poor geological portion. In many ways, achieving work progress was not easy, and each day was a new beginning for the project engineering team.

During project execution, the Uri-II team encountered frequent flooding of River Jhelum, (both seasonal and non-seasonal), which resulted in the washing away of both upstream and down steam cofferdams almost every season. Despite these circumstances, the project team successfully completed the dam structure with a total concrete quantity of 1.00 lakh cubic metre during March 2011, except for the apron structure, that carries water from the dam to the head race tunnel.

In order to adhere to the Indus water treaty agreement executed between the Government of India and Pakistan, there was a requirement for impounding the reservoir before August 20, 2011. Subsequently, NHPC requested HCC to complete the apron structure of the dam during the monsoon of June 2011, within a target duration of 25 days.

R. Rajendrakumar, Project Manager, elaborated, "The project team took up this challenge and mobilized all additional resources required to complete the apron structure within this stipulated timeline. To construct this apron, we were required to excavate for the foundation at EL 1196m and the excavated muck had to be disposed at EL 1220 m,(with the level difference of 24m), in the absence of haul roads, and with limited space. We deployed seven excavators in a series from bottom to the top, to transfer the excavated muck from the foundation to the disposal area, and completed the excavation and concreting of the apron structure. Another major challenge encountered was seepage from the downstream cofferdam. To tide over this seepage, we deployed 20 units of 50 HP capacity dewatering pumps, each with



Concrete lining in progress at the Tail Race tunnel.

a discharge capacity of 6,000 litres per minute. Each pump was run continuously for 25 days to avoid any obstruction during construction of the apron structure. With total commitment, the project team completed this apron structure within the 25 day duration and the reservoir was impounded during the first week of August 2011."

Another challenge was encountered during excavation of the Tail Race Tunnel through Adit-IV upstream and downstream during the monsoon periods. It was clearly envisaged from the construction drawings that the bottom level of the tunnel would be lower than the river bed level. Even after these adverse geological conditions and critical project conditions, the Uri-II team was able to optimally address all the scenarios on hand and were able to successfully complete the major works for commissioning of the project.

Tunneling through adverse geology

Though while excavating for the headrace tunnel, the rock class encountered was of class 3 and 4, the tailrace tunnel engineers encountered riverine materials for a length of 223 m. This consists of earth mixed with boulders, together with heavy seepage of about 15,000 litres per minute. To excavate in these very loose earth strata following methods were adopted:

- Only exposed boulders on the face were removed by blasting, subsequently the earth surrounding the boulders were removed using excavators.
- Shotcrete and Consolidation Grouting on the face was carried out to stabalise the tunnel face.
- Dewatering pumps were deployed to a capacity of 600 hp, in stages to tackle the seepage.
- To avoid loose fall from the crown, specialised pipe roofing using Mai anchors were installed on the crown of the tunnel as umbrella. This pipe roofing with Mai Anchors were installed by drilling holes with self sacrificing drill bits, for a length of 18m, along with perforated pipes and the same was grouted with cement grout.
- Advancement of tunnel was carried out cautiously to avoid any mishap with rib support and back fill concreting after the activities mentioned above.

Finally, this entire stretch of the tail race tunnel (with a poor geological zone) was lined with Reinforced concrete. To mitigate this delay in excavation in tailrace tunnel, an additional face was identified from downstream surge gallery.

Dewatering

The seepage encountered in the Tail Race Tunnel, Power House and dam area was huge, as the nallahs that were crossing over the TRT

Components	Description
Diversion Tunnel	337 m in length, 8.8 m diameter, Horse-shoe shaped.
Dam	Concrete gravity dam, maximum height 43.7 m, 157 m in length
Spillway	60 m wide, 4 no. of bays each of 9 m width, Orifice type with breast wall.
Head Race Tunnel	Horse-shoe shaped, 4.23 km in length, 8.4 m in diameter, concrete lined,
Surge Shaft	Open to air, Restricted Orifice Type, 78 m in height, 25 m in diameter.
Pressure Shaft / Penstock	2 nos., underground, circular steel-lined, 5 m (internal) diameter, Length from Surge Shaft to MIV is 170/188, Length from MIV to PH 34.5 m each.
Power House	Underground, Power House Cavern 133.0 m X15.0 m X40.0 m, Transformer/GIS Cavern 170.5 m X 14.0 m X 13.0 m, Gross Head 130 m, Net operating head 118 m, Design Discharge 225 m3/sec, 4 Nos. Draft Tube Gates.
Tail Race Tunnel	8. 4 m (Horse shoe shaped, concrete-lined), 3.757 km in length

The underground power house

View from Left Bank of the Dam

alignment and the crown of the underground Power House was designed 22m below the river water level. The project team ensured uninterrupted dewatering in the TRT, Power House and Dam area till the completion of the project. Total dewatering quantity in this project was 345 million kilowatt hours. Total electrical cables used to maintain this dewatering arrangement in tunnels was 15,000m.

Social Challenges

During project execution, there were calls for bandh and strike during 2008 and during 2010 and a continuous curfew was imposed in the state for months together, especially in Baramulla district, where the project was located. During this period, there was no traffic on NH 1A which affected the supply of vital construction materials. There was a high labour turnover during this period due to fear psychosis. In this scenario, skilled manpower was drawn from outside J&K, with help from the Head Office subcontracts department. Thus, the project team was able to sustain work progress.

On Friday, July 4th 2014 Prime Minister Narendra Modi inaugurated the 240-Megawatt Uri-II Hydro Electric Project (HEP) The Prime Minister dedicated the power project to the nation in presence of Jammu and Kashmir Governor N.N. Vohra, Chief Minister Omar Abdullah and top officials of National Hydroelectric Power Corporation (NHPC).

Major Quantities

Common excavation	19.24 lac cum
Rock excavation	6.70 lac cum
Underground excavation	9.80 lac cum
Rock bolts	3.20 lac RM
Rock anchor	0.20 lac RM
Embankment construction	3.43 lac cum
Concrete	5.10 lac cum
Steel	15275 MT

Equipment Used

DG set	16 no's
Boomer	7 no's
ROC	6 no's
Compressor Diesel	10 no's
Compressor Electrical	7 no's
Batching Plant	3 no's
Crushing Plant	1 no
Concrete Pump	9 no's
Transit mixer	21no's
Formwork Gantry	7 no's
Dozer	3 no's
Excavator	15 no's
JCB	2 no's
Loader	8 no's
Crane	2 no's
Tower Crane	3 no's
Tata Dumper 10 Ton	100 no's
Tata Dumper 15 Ton	7 no's
Mitsui Dump truck	5 no's
Ajax fiori Dumper	9 no's
Cifa Shotcrete M/c	4 no's

DID YOU KNOW ?

Second oldest power plant in Indian subcontinent was near Uri.

Mohra Power house, setup near Uri, in J&K, was the second powerhouse in the Indian subcontinent. When the Maharaja of Mysore set up the Kaveri Power scheme in 1902 at Shivasamudram to electrify Kolar Gold Fields and later Mysore and Bangalore, the Kashmir monarch Ranbir Singh hired the same legendry engineer Major Dlain de Latbiniere to set up this power project in Uri.

The powerhouse had a capacity of 200 kilowatts but given the low demand and requirement, only one generator of 5000 HP, 25 Hz, 3 phases was installed. The generator was supplied by General Electric Company of New York and the prime mover for generator water wheel was supplied by Abner Doble of San Francisco. The wooden flume successfully got 200 cusecs of water that would drive the turbines.

The project started generation in 1905. Initially, the plant had turbines with 25 cycles against the standard frequency of 50 cycles with the result that the power was supplied at a voltage of 400 volts. After some years, conversion from 25 to 50 cycles machinery costing about two crore rupees was set up to add 600 kilowatts to the existing capacity.

The surplus power was diverted to Srinagar Silk Factory for heating the water basins in which cocoons are immersed for reeling. Then, Srinagar had the largest Silk Factory in the world producing around 100 tons of silk a year. The electric current improved various cottage industries and lit vast belts including Maharaja's Srinagar palaces. However, the power of 3.75 MW generated then at Mohra was far too surplus for the valley.

Mohra was the only source of power supply for Kashmir till the year 1955. Mohra continued generating power till July 1959 when it was struck by unprecedented floods in Jhelum. The flood waters hit the Power plant, shearing its building longitudinally into two halves.