Sainj Hydroelectric Power Project

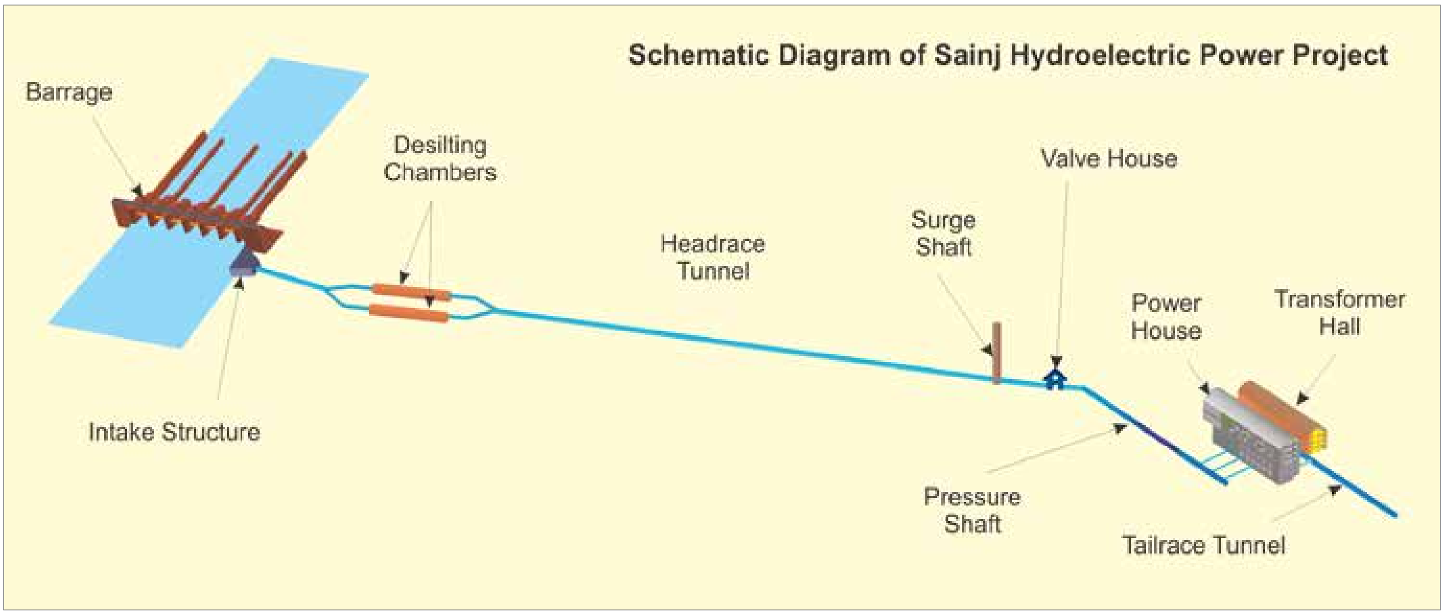
The barrage nearing completion at the 100MW Sainj Hydroelectric Power Project in Kullu district of Himachal Pradesh

Background

Sainj River is a major tributary of Beas that originates from west of Rakti Dhar at an elevation of 5500 meters. It traverses in the west before joining river Beas near Larji village. A sub-tributary, Jiwa nallah, joins Sainj near village Suind. The catchment area of Sainj River is 650 km^2 out of which 152 km^2 remains permanently under snow cover. The Sainj River has a leafy catchment that comprises of forests on hill slopes.

Two hydroelectric projects, Parbati III (520MW) and Larji HEP (126MW), are already operational on the Sainj River and a third project, Sainj HEP (100MW), is currently under implementation immediately upstream of the development of the Parbati III project. HCC was awarded the EPC contract to construct the Sainj Hydroelectric Power Project by the Himachal Pradesh Power Corporation (HPPCL) in August 2010. The project will generate 399.57 GWh in a 90% dependable year and 436.90 GWh in a 50% mean year pattern of flow. The project is proposed to be operated as a peaking station for power absorption in the Northern Grid.

The scope of work	
1.	A diversion barrage: 24.5m high and 150m in width with 6 radial gates for spillway and an intake arrangement
2.	An underground de-silting arrangements comprising two chambers of 139m X 15m X 9m dimensions
3.	A modified horseshoe shaped headrace tunnel: 6300m long with 3.85m diameter
4.	Restricted orifice type surge shaft: 75m high with 9m diameter
5.	A 550m long steel lined pressure shaft feeding two Peltron Vertical Axis turbines generating 50 MW each
6.	An Underground Powerhouse
7.	A GIS 220 KV Switchyard
8.	A Tail Race Tunnel



Mobilization Challenges

The mobilization of the workforce, material and equipment began immediately after awarding the contract in August 2010. The work was to start on all fronts of the project. However, being in a remote area, accessibility to various fronts was a big challenge. Though the project location was just 35 km from the National Highway (NH21), the roads from the highway to the site were not adequate to carry long trailers carrying equipments. Hence all equipment transportation was done in smaller trucks.

The access road for the project was on the left bank of the river and the powerhouse was located on the right bank. The access bridge was to be provided by the client, but the project team could not afford to wait for the bridge to be built.

A temporary bridge solution was adopted by putting 3 meter diameter hume pipes in the course of the river so that the flow does not get affected. Gravels were put on these pipes to create a temporary bridge good enough to carry the men, material and equipment on the right bank, to start work on the main access tunnel of the power house.

The access to HRT through Adit 1 was not much of a problem. However, access to barrage site was another challenge. For accessing the barrage site, the river was to be crossed at two locations near Samba village where the bridges were still to be built. Here, the narrow valley and depth of the river could not allow the team a similar arrangement like power house access. Hence, the team indigenously built a temporary bridge by constructing abetments by wire crates on which steel girders were placed.

This temporary bridge was good enough to carry across the required equipment and material to commence the work at the barrage location.

Electricity for various fronts

Electricity was made available on various fronts on a piece meal basis. It took nearly two years to get permanent electricity supply for all work fronts. But the work never stopped because of lack of electricity. The project team worked with the help of DG sets to carry out the work as per schedule. The additional charges on account of the DG set operations were claimed separately from the client.

Design delivery

In an EPC contract, coordination with various parties involved, such as the client, consultants and various contractors, is essential for timely delivery. Many a times their jobs are interdependent. Hence an effective teamwork and a well established process ensures timely delivery.

For example, the basic designs of the project are provided by the client. These are studied by HCC's design consultant, AF Colenco, in coordination with the Engineering Department at the HCC head office. They submit detailed designs, component wise. These designs are studied by the project team for ease of construction and then referred to the client for final approval before actual construction begins.

In Sainj HEP, HCC's hydro-mechanical contractor is GMW, Baroda and HPPCL's Electro-mechanical contractor is Voith, Germany. The coordination between these teams was so precise that the project timelines never suffered for want of design.

"Planning of each activity and the responsibility matrix were defined right up to the worker level. Furthermore, the team was encouraged to participate in open discussions and provide solutions to every problem encountered during implementation of the Project and I am proud to lead such an enthusiastic and skilled team of HCC."

- V. K. Reddy, Project Manager, HCC.

Changes in design of the barrage and diversion channel

As per the contract, the barrage consisted of four bays and for building the barrage, the river diversion was to be carried out in an open channel in three steps. The model study fell under HCC's scope of work, wherein a prototype of the barrage is created to study the design flood criteria. It was found that the existing design of the four bays was not enough to carry the required flood discharge of 3060 cumecs. Hence the barrage design was changed to six bays to give it more stability and meet the required flood discharge. While doing so, the river diversion mechanism was also changed to a simpler two step process. In the first stage, the river was diverted from the left bank and two of the six bays were built on the right bank. After completion of these two bays, the river was diverted through these completed bays which allowed the team to work on the remaining four bays seamlessly.

Fish ladder and ecological pipe

The water demand of fisheries has been kept as 1 cumec (which is around 15% of river flow during the lean period) as permanent flow through Sainj river on account of environmental safeguarding. The water will be released through fish ladder which has been provided on the left bank of the barrage and a separate ecological pipe which will have a flow meter to regulate 1 cumec discharge in both lean and peak periods. The gated pool type fish ladder is 60 m long. The fish ladder was specially provided for the upstream migration of fish, trout fish in this case.

Surge shaft excavation

The access road to the surge shaft was to be built by HCC. However, the terrain was so difficult that the team could reach only up to the portal at bottom of the surge shaft and building access road to the portal at the top of the surge shaft was practically impossible. Hence, an underground access route was dug out from the portal at the bottom of the surge shaft to the portal at the top of the surge shaft. While excavating this underground route, the team encountered bad geology towards the top end and extensive rib supports and back filled concrete was used to stabilize the route.

The desilting chamber of the underground water conductor system of Sainj Hydroelectric Power Project

The surge shaft is normally excavated from top to bottom and the muck disposal happens from the top portal. However, since the access to the portal at top of the surge shaft was so difficult, the team came up with an innovative solution. A pilot shaft of 3 m diameter was excavated from the bottom to the top. By that time the access route to the top of the shaft was completed and the remaining portion of the 10.1 meter diameter surge shaft was to be done by slashing and collecting muck at the bottom of the surge shaft where it would be comparatively easier to dispose off.

Poor Geology at De-silting Chamber

De-silting Chambers have gates to control the flow of water into the head race tunnel. A permanent tunnel of 5 m diameter is built to access these gates which are generally built on a slightly higher elevation than the de-silting chambers, with independent shafts opening up close to the gates. While excavating this permanent tunnel, immensely bad geology was faced by the team where the roof of tunnel in 8 meter area collapsed, forming a huge cavity of almost 20 m height. To avoid further collapse of the tunnel, the face of the tunnel was immediately closed and adequate supports were installed. The cavity was first filled with low strength concrete and then it was carefully excavated by very controlled blasting to bore the tunnel through it with more rib supports and fore-polling. About 1000cum low strength concrete was used to fill the cavity. 10,000 bags of cement grout, 5 MT fore-poling and 15 MT structural steel were consumed in cavity treatment.

Similarly, the end portion of both the de-silting chambers had bad geology and extensive support structures were provided before completing the finished layer of concrete in the De-silting Chamber. For completing this 48 meter stretch of the permanent tunnel to access the gates and the end portion of De-silting Chamber, it took 20 months.

Additional supports provided at the access tunnel due to poor geology

The 3.85m diameter Head Race Tunnel constructed using long distance concrete pumping methodology.

Choosing long distance pumping

The finished diameter of the 6.3km long Head Race Tunnel is 3.85m with an average lining thickness of 0.25m. In such a small diameter tunnel, vehicle movement and crossing are restricted and carrying out multifarious activities of concrete lining poses a severe challenge due to congested working space. The movement of concrete conveying transit mix is often restricted to one way traffic only. The temperature, humidity and installation of an adequate ventilation system also creates challenging working conditions as the tunnel length increases.

To overcome these problems, the project team decided to use long distance concrete pumping for the concrete lining work of Head Race Tunnel. Although the long distance concrete pumping has several advantages such as reduced cost, improved speed of construction and most importantly enhanced quality of construction, it has serious challenges as a technique. The pump was installed at a location from where the concrete was needed to be pumped up to 1.36 km upstream and 2.432 km downstream. For pumping the concrete to such long distances, selection of concrete pump, layout of concrete conveying pipeline, selection and quality control of concrete materials, dealing with diverse climatic conditions and above all, safe execution of operations were crucial.

The underground powerhouse cavern at Sainj HEP

After scrutinizing various options, a Schwing Stetter SP 4800 pump was selected. Depending on the pumping distances (and hence the pressures), this pump had dual pumping mechanism - the piston side for long distance pumping and the rod side for short distances. The team developed a protocol for correlating the pump back-pressure with concrete properties. The engineers ensured continuity of the long distance pumping through continuous inspections and maintenance during pumping and in idle conditions to avoid any kind of breakdown.

After selection of the pump, the second challenge was selecting the right pipe diameter. Considering the required flow rates and the productivity and pressure considerations, the team chose a 150 mm internal diameter pipeline. To sustain high pumping pressure, a variable thickness pipeline was selected (10 mm thick near the pump and 7 mm thick thereon in). An important part of the pipeline is the clamp and the associated safety, since the working pressures are much higher than they conventionally are and possibly dangerous, if not handled properly.

During installation and operations, a complete and thorough cleaning of pipeline is very essential as even a small chunk of concrete remaining inside the pipeline has the potential for disrupting the pumping operation. The project team had organized rigorous training of the cleaning team for safe and efficient operations. Adequate lighting, ventilation and constant dewatering and cleaning were ensured for effective working.

After critically studying the materials – equipment – processes – human resources, HCC objectively translated the same into specific concrete parameters, process parameters and associated control points. With the help of a specially formulated chemical admixture, the Self Compacting Concrete (SCC) with specific setting time was chosen for maintaining the required time cycle. The setting times were measured in the lab as well as on field for better control.

Since the project is located in the Himalayan region, the temperature difference at the pumping location and pouring location ranged from 5°C to 40°C. This could cause the concrete mix to change properties during pumping. To overcome such difficulties, rigorous lab and field tests continuously guided the execution.

WORLD RECORD

"While attempting the world record in long distance concrete pumping, the project team exhibited extraordinary characteristics of seamless cooperation, trust and team work to deliver concrete across the long distance of 2.432 km."

- V. K. Reddy, Project Manager, HCC

The HCC Project team created a World Record in Long Distance Concrete Pumping on February 26, 2014 by successfully pumping concrete for a distance of 2432 meters. The previous world record in long-distance concrete conveying was 2015 meters, set by the French concrete pump service Transbeton, whilst carrying out refurbishing work in a hydraulic water gallery in Haut Doubs at the Le Refrain construction site, near the Swiss border.

Safety achievements

Safety had been of paramount importance while constructing the Sainj HEP, which was amply demonstrated by the project team by achieving 8.6 million safe man-hours by end of March 2015. The project team has been conducting safety programmes on lines of the calendar fixed by the HCC Head Office.

Till date, 309 training programmes have been conducted which were attended by 5017 officers and workmen. These include vehicle incidents and traffic management; Behavior based safety awareness; Proactive safety observation; Near miss reporting; Occupational health & hygiene; Drilling and blasting techniques and safety precautions; defensive driving; Heavy lifting; Safe electrical handling; Scaffolding simulation at working place etc.

The project has been recognized by the HCC head office for its excellence in Safety performance twice – in the first half of FY2013-14 and for the annual awards in FY2013-14.

Environment Management

The project team has been meeting all the statutory compliances set-up by authorities including Noise, Air and Water pollution norms for the project. Besides these, the project team has undertaken several initiatives to support the environment protection initiatives of the company.

As a signatory of United Nations Global Compact's "CEO Water Mandate", the project team has been undertaking various initiatives to conserve water in its operations. A rainwater harvesting set-up has been undertaken, connecting all the storm water drainage from the camp building to recharge an empty bore well located at the project site. Flow meters have been set-up in all overhead tanks within the project premises, which automatically switch the pump off, saving valuable drinking water.

The food waste generated at the camp and worker's mess has been treated in a composting unit set-up in the vicinity, with a 21 day cycle to produce fertilizer which is used for horticulture in and around the project site.

Himachal Pradesh Power Development Corporation (HPPCL) has been conferred with Greentech Environment Award-2015 for good environmental management to its 100 MW Sainj Hydel Power Project. The award was bestowed for meticulously implementing Environment Management Plan (EMP) at Sainj Hydroelectric Power Project. The award was presented by AM Chakraborti, former Chief Secretary, West Bengal, at a function organized in Kolkata. The award was received by Rakesh Sood, Chief Environment Specialist, HPPCL and Ajay Kumar Bisht, Deputy General Manager (Quality Control), HPPCL.

Rainwater harvesting at camp site

Food waste treated at decomposting pit

Flow Meter Installed in overhead water tank

Greentech Environment Award to HPPCL for Sainj HEP