

## **AN OVERVIEW OF RANJIT SAGAR DAM PROJECT, GURDASPUR DISTRICT, PUNJAB**

The Ranjit Sagar Dam, a multipurpose project over River Ravi, commissioned in March, 2001, is a fine embodiment of inter-state relationship and cooperation between Punjab and Jammu & Kashmir states. Located near Pathankot in Gurdaspur district of Punjab, the project comprises 160m high, 600m long rockfill dam with a surface Power House of 600 MW installed capacity. The foundation gallery below the clay core running all through the dam foundation is a unique feature and first of its kind in a rock fill dam in India. The association of Geological Survey of India with the Project stems way back to the time of its conception. The initial investigation for assessing the feasibility of the Project began in 1953, while subsequent systematic geotechnical investigations continued till 1980, and later, when it came under construction in 1981. GSI's contribution continued at every stage and the geological inputs by GSI formed the basis for finalization of the most suited design of project components.

The project is located on the south-western limb of regional anticline comprising 4-40m thick sandstone and 4- 30m thick claystone / siltstone bands of Lower Siwalik in the Outer Himalaya. The disposition of various lithounits is about 45° askew to the dam axis with traceable continuity of different litho-bands from left to the right abutment. Besides some less persistent joints, the lithounits are dissected by two major joint sets, parallel to the bedding, and striking NE-SW with sub-vertical to vertical dips. Showing local folds also, the rocks are dissected by two faults in the left Spillway area and by a group of more prominent, approximately WNW-ESE trending faults, in the inlet portal area of the diversion tunnels. Development of shears and fractures in rocks, mainly parallel to the bedding plane, are common. Rock creep was observed in the bucket portion of the spillway.

The Dam area is located in most active Seismic Zone-V as per the Seismic Zoning Map of India (ISI 1895-1970), on the western fringe of Kangra Seismic Block, which is demarcated by Ravi Tear in the west and Sundernagar Fault in the east. Hence, suitable seismic co-efficients have been provided for the safe design of the dam.

The Ravi waters, during the diversion stage, were routed through four, 12m diameter circular tunnels located in the left abutment hill and excavated through alternating bands of sandstone and claystone / siltstone. After completion of the project, two of the diversion tunnels, P-1 and P-2, are being used as power tunnels to feed four units of 150 × 4 MW capacity surface power house. The remaining two tunnels, T-1 and T-2, serve as irrigation outlets to fulfill the commitments of the downstream command areas.

In this Dam, a R.C.C. foundation gallery of size 2.5 × 2 m has been provided having a varying thickness with minimum of 0.75 m. The foundation gallery lies in rock just below the clay core of the Dam.

Foundation grade geological mapping of the clay core base on scale 1: 200 was carried out and the geological features have been recorded for future reference. During every stage of construction of the dam, geological advice has been provided to ensure the safety of the structure. The clay core base has been placed from elevation  $\pm 392$  m to elevation  $\pm 400$  m. This was found to be generally 3 to 6m higher than the anticipated levels on the basis of subsurface exploration data. During the course of mapping, loose, weathered and open jointed rock in the core base foundation was removed prior to clay placement. The area grouting of core base area of Dam was done before placement of clay. The 15m deep holes for area grouting were drilled in hexagonal pattern at 6m c/c. The depth of the area grouting was kept 15m up to El. 461m, and above 461m the depth was reduced to 10m. The average grout intake in the holes for area grouting was 18 bags per hole in general, except in some holes in Sandstone Bands where maximum grout intake in one hole was reported to be 283 bags. Also, a single row, about 60m deep, grout curtain has been created at a distance of 10m on the upstream side of foundation gallery.

The 133m wide and 547.55m long spillway structure of RS Dam consists of ogee shaped crest at elevation 512m with seven radial gates followed by spillway chute with 1:30 gradient and steep 1:1 plunge slope joining with energy dissipation arrangement. The energy dissipation arrangement consists of a combination of stilling basin at elevation 402m, ogee weir and a roller bucket at elevation 385m. The construction of the Spillway structure was a challenging task as it involved huge rock cutting on the left side. The foundation mapping revealed that the actual geological conditions were similar to those foreseen during the investigation stage. Stability problems were visualized in excavation of the plunge slope and left flank of the spillway and suitable measures were suggested to stabilize them.

The Power House consisting of four generating units of 150 MW each, has an installed capacity to produce 600 MW and has been located 360m downstream of the dam axis, on the left bank of river Ravi. It's long axis is aligned parallel to the strike of the rock bands, so that the upstream and downstream ends of the powerhouse are located on sandstone band 40B and 41B respectively. The powerhouse foundation grade is designed at elevations varying from 387.57m to 389.27m, which is about 14.80m to 16.5m below the river bed level. The foundation had 1:1 slope in downstream direction.

The project has immensely benefited the Nation and particularly the States of Punjab and Jammu & Kashmir by providing the much needed electricity and water for irrigation to the farmers besides flood moderation.



**Photo 1: A Panoramic and composite view of Ranjit Sagar Dam Project in final stages of construction (view from right bank of Ravi River)**





**Photo 2: Construction of False Structural Portals at Inlets of Diversion Tunnels in Progress**



**Photo 3: Panoramic view from right bank of Ravi looking upstream ( at the beginning of construction of project), showing Outlet Portals of the Diversion Tunnel and excavation of the Power House pit. The dam axis lies just upstream of Power House location in the left background across Ravi**



**Photo 4: View of Dam looking towards right abutment at higher elevation. Impervious Clay Core flanked by upstream (towards right) and downstream (towards left). Filters and pervious Shell Zones compacted by rollers**



**Photo 5: Left flank Spillway construction under progress. Hill-cut benches towards left side, shotcreted and covered with concrete claddings are also seen.**





**Photo 6: Power House construction under progress. Foundation being designed as raft foundation over rocks of varying competency**



**Figure 7: Ranjit Sagar Dam commissioned on 4<sup>th</sup> March 2001**